

SECTION 01330
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES

Not Used

1.3 SUBMITTALS

A standard transmittal form provided by the Government shall be used to transmit each submittal.

Submittal Description (SD): Drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials to be furnished by the Contractor explaining in detail specific portions of the work required by the contract.

The following items, SD-01 through SD-11, are descriptions of data to be submitted for the project. The requirements to actually furnish the applicable items will be called out in each specification.

SD-01 Preconstruction Submittals

Submittals which are required prior to a notice to proceed on a new contract. Submittals required prior to the start of the next major phase of the construction on a multi-phase contract. Schedules or tabular list of data or tabular list including location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work, submitted prior to contract notice to proceed or next major phase of construction.

SD-02 Shop Drawings

Submittals which graphically show relationship of various components of the work, schematic diagrams of systems, detail of fabrications, layout of particular elements, connections, and other relational aspects of the work.

SD-03 Product Data

Data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents.

SD-04 Samples

Samples, including both fabricated and unfabricated physical examples of materials, products, and units of work as complete units or as portions of units of work.

SD-05 Design Data

Design calculations, mix design analyses, or other data, written in nature, and pertaining to a part of the work.

SD-06 Test Reports

Written reports of a manufacturer's findings of his product during field inspections, attesting that the products are installed in accordance with the manufacturer's installation instructions, shop drawings, or other manufacturer's requirements. Written reports by a general contractor or his subcontractors including daily logs reporting on the progress of daily activities or attesting that the work has been installed in accordance with the contract plans and specifications.

SD-07 Certificates

A document, required of the Contractor, or through the Contractor by way of a supplier, installer, manufacturer, or other Lower Tier Contractor, the purpose of which is to further the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel, qualifications, or other verification of quality.

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. Statements must be dated after the award of this contract, name the project, and list the specific requirements which it is intended to address.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system, or material, including special notices and material safety data sheets, if any concerning impedances, hazards, and safety precautions.

SD-09 Manufacturer's Field Reports

A written report which includes the findings of a test made at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation. Report must be signed by an authorized official of a testing laboratory or agency and must state the test results; and indicate whether the material, product, or system has passed or failed the test.

SD-10 Operation and Maintenance Data

Data intended to be incorporated in an operations and maintenance manual.

SD-11 Closeout Submittals

Special requirements necessary to properly close out a construction contract. For example, as-built drawings, manufacturer's help and product lines necessary to maintain and install equipment. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

1.4 PREPARATION

1.4.1 Marking

- Permanent marking shall be provided on each submittal to identify it by contract number; transmittal date; Contractor's, Subcontractor's, and supplier's name, address(es) and telephone number(s); submittal name; specification or drawing reference; and similar information to distinguish it from other submittals. Submittal identification shall include space to receive the review action by the Contracting Officer.

1.4.2 Drawing Format

Drawing submittals shall be prepared on translucent, reproducible sheets, not less than 8-1/2 by 11 inches nor larger than 30 by 42 inches in size, except for full size patterns or templates. Drawings shall be prepared to accurate size, with scale indicated, unless other form is required. Drawing reproducibles shall be suitable for microfilming and reproduction on the Diazo or Ozalid machines and shall be of a quality to produce clear, distinct lines and letters. Drawings shall have dark lines on a white background.

Copies of each drawing shall have the following information clearly marked thereon:

- a. Job name, which shall be the general title of the contract drawings.
- b. Date of the drawings and revisions.
- c. Name of Contractor.
- d. Name of Subcontractor.
- e. Name of the item, material, or equipment detailed thereon.
- f. Number of the submittal (e.g., first submittal, etc.) in a uniform location adjacent to the title block.
- g. Government contract number shall appear in the margin, immediately below the title block.

Drawings shall be numbered in logical sequence. Contractor may use his own number system. Each drawing shall bear the number of the submittal in a uniform location adjacent to the title block. Government contract number shall appear in the margin, immediately below the title block, for each drawing.

A blank space, no smaller than 4 inches by 4 inches shall be reserved on the right hand side of each sheet for the Government disposition stamp.

1.4.3 Data Format

Required data submittals for each specific material, product, unit of work, or system shall be collected into a single submittal and marked for choices, options, and portions applicable to the submittal. Marking of each copy of product data submitted shall be identical. Partial submittals will be accepted for expedition of construction effort.

1.4.4 Samples

Samples shall be physically identical with the proposed material or product to be incorporated in the work, fully fabricated and finished in the specified manner, and full scale. Where variations in color, finish, pattern, or texture are inherent in the material or product represented by the sample, multiple units of the sample, showing the near-limits of the variations and the "average" of the whole range (not less than 3 units), shall be submitted. Each unit shall be marked to describe its relation to the range of the variation. Where samples are specified for selection of color, finish, pattern, or texture, the full set of available choices shall be submitted for the material or product specified. Sizes and quantities of samples shall represent their respective standard unit.

1.5 SUBMISSION REQUIREMENTS

1.5.1 Schedules

At the Preconstruction conference, the Contractor shall provide, for approval by the Contracting Officer, the following schedule of submittals:

- NTM-115
- a. A schedule of shop drawings and technical submittals required by the specifications and drawings. Schedule shall indicate the specification or drawing reference requiring the submittal; the material, item, or process for which the submittal is required; the "SD" number and identifying title of the submittal; the Contractor's anticipated submission date and the approval need date.
 - b. A separate schedule of other submittals required under the contract but not listed in the specifications or drawings. Schedule will indicate the contract requirement reference; the type or title of the submittal; the Contractor's anticipated submission date and the approved need date (if approval is required).
 - c. Submittals called for by the contract documents will be listed on one of the above schedules. If a submittal is called for but does not pertain to the contract work, the Contractor shall include it in the applicable schedule and annotate it "N/A" with a brief explanation. Approval of the schedules by the Contracting Officer does not relieve the Contractor of supplying submittals required by the contract documents but which have been omitted from the schedules or marked "N/A".
 - d. Copies of both schedules shall be re-submitted monthly annotated by the Contractor with actual submission and approval dates. When all items on a schedule have been fully approved, no further re-submittal of the schedule is required.

1.5.2 Drawings Submittals

1 translucent reproducible copy and 2 blackline or blue-line opaque prints of each drawing shall be submitted. Reproducible copies, marked with review notations by the Contracting Officer, will be returned to the Contractor.

1.5.3 Data Submittals

Five complete sets of indexed and bound product data shall be submitted. Two sets, marked with review notations by the Contracting Officer, will be returned to the Contractor.

1.5.4 Samples

One set of identified samples shall be submitted. A copy of the transmittal form, marked with review notations including selections by the Contracting Officer, will be returned to the Contractor.

Samples that are intended or permitted to be returned and actually incorporated in the work are so indicated in the individual technical sections. These samples will be returned to the Contractor, at his expense, to be clearly labeled, with installation location recorded. Samples shall be in undamaged condition at the time of installation.

Where mockups and similar large samples are required by individual technical sections, it is recognized that these are a special type of sample which cannot be readily "transmitted" as specified for submittal of samples. Otherwise, and except as indicated in the individual technical sections, the requirements for samples shall be complied with and a transmittal form shall be processed for each mockup, to provide a record of the activity.

1.6 GOVERNMENT'S REVIEW

1.6.1 Review Notations

Contracting Officer will review submittals and provide pertinent notation within 10 calendar days after date of submission. Submittals will be returned to the Contractor with the following notations:

- a. Submittals marked "approved" authorize the Contractor to proceed with the work covered.
- b. Submittals marked "approved as noted" authorize the Contractor to proceed with the work covered provided he takes no exception to the corrections. Notes shall be incorporated prior to submission of the final submittal.
- c. Submittals marked "return for correction" require the Contractor to make the necessary corrections and revisions and to re-submit them for approval in the same routine as before, prior to proceeding with any of the work depicted by the submittal.
- d. Submittals marked "not approved" or "disapproved" indicate noncompliance with the contract requirements and shall be re-submitted with appropriate changes. No item of requiring a submittal shall be accomplished until the submittals are approved or approved as noted.
- e. Contractor shall make corrections required by the Contracting Officer. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications; notice as required under the clause entitled, "Changes" shall be given to the Contracting Officer. Approval of the submittals by the Contracting Officer shall not be construed as a complete check, but will indicate only that the

general method of construction and detailing is satisfactory. Contractor shall be responsible for the dimensions and design of connection details and construction of work. Failure to point out deviations may result in the Government requiring rejection and removal of such work at the Contractor's expense.

- f. If changes are necessary to approved submittals, the Contractor shall make such revisions and submission of the submittals in accordance with the procedures above. No item of work requiring a submittal change shall be accomplished until the changed submittals are approved.

1.6.2 Sample Approval

Contractor shall furnish, for the approval of the Contracting Officer, samples required by the specifications or by the Contracting Officer. Shipping charges shall be paid by the Contractor. Materials or equipment requiring sample approval shall not be delivered to the site or used in the work until approved in writing by the Contracting Officer.

Each sample shall have a label indicating:

- a. Name of project
- b. Name of Contractor
- c. Material or equipment
- d. Place of origin
- e. Name of producer and brand
- f. Specification section to which samples applies
- g. Samples of furnished material shall have additional markings that will identify them under the finished schedules.

Contractor shall submit to the Contracting Officer two samples of materials where samples are requested. Contractor shall transmit with each sample a letter, original and two copies, containing the above information.

Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify any contract requirements. Before submitting samples, the Contractor shall assure that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

Materials and equipment incorporated in the work shall match the approved samples. If requested, approved samples, including those which may be damaged in testing, will be returned to the Contractor, at his expense, upon completion of the contract. Samples not approved will also be returned to the Contractor at its expense, if so requested.

Failure of any materials to pass the specified tests will be sufficient cause for refusal to consider, under this contract, any further samples of the same brand or make of that material. Government reserves the right to disapproved any material or equipment which previously has proved unsatisfactory in service.

Variations from contract requirements shall be specifically pointed out in transmittal letters. Failure to point out deviations may result in the Government requiring rejection and removal of such work at no additional cost to the Government.

Samples of various materials or equipment delivered on the site or in place may be taken by the Contracting Officer for testing. Samples failing to meet contract requirements will automatically void previous approvals. Contractor shall replace such materials or equipment to meet contract requirements.

Approval of the Contractor's samples by the Contracting Officer shall not relieve the Contractor of his responsibilities under the contract.

1.7 PROGRESS SCHEDULE

1.7.1 Bar Chart

Contractor shall:

- a. Submit the progress chart, for approval by the Contracting Officer, at the Preconstruction Conference in one reproducible and 4 copies.
- b. Prepare the progress chart in the form of a bar chart utilizing form "Construction Progress Chart" or comparable format acceptable to the Contracting Officer.
- c. Include no less than the following information on the progress chart:
 - (1) Break out by major headings for primary work activity.
 - (2) A line item break out under each major heading sufficient to track the progress of the work.
 - (3) A line item showing contract finalization task which includes punch list, clean-up and demolition, and final construction drawings.
 - (4) A materials bar and a separate labor bar for each line item. Both bars will show the scheduled percentage complete for any given date within the contract performance period. Labor bar will also show the number of men (man-load) expected to be working on any given date within the contract performance period.
 - (5) The estimated cost and percentage weight of total contract cost for each materials and labor bar on the chart.
 - (6) Separate line items for mobilization and drawing submittal and approval. (These items are to show no associated costs.)
- d. Update the progress schedule in one reproduction and 4 copies every 30 days throughout the contract performance period.

1.7.2 Project Network Analysis

Contractor shall submit the initial progress schedule within 21 days of

notice to proceed. Schedule shall be updated and resubmitted monthly beginning 7 days after return of the approved initial schedule. Updating shall entail complete revision of the graphic and data displays incorporating changes in scheduled dates and performance periods. Redlined updates will only be acceptable for use as weekly status reviews.

Contractor shall provide a single point contact from his on-site organization as his Schedule Specialist. Schedule Specialist shall have the responsibility of updating and coordinating the schedule with actual job conditions. Schedule Specialist shall participate in weekly status meetings and present current information on the status of purchase orders, shop drawings, off-site fabrication, materials deliveries, Subcontractor activities, anticipated needs for Government furnished equipment, and any problem which may impact the contract performance period.

Project network analysis shall include:

- a. Graphic display shall be a standard network or arrow diagram capable of illustrating the required data. Drafting shall be computer generated on standard 24 by 36 inch (nominal size) drafting sheets or on small (11 by 17 inch minimum) sheets with separate overview and detail breakouts. Any graphic display system used shall be readily legible with a clear, consistent method for continuations and detail referencing. Critical path shall be clearly delineated on the display. When milestone dates are included in the Contract they shall be clearly indicated on the display.
- b. Data shall be presented as a separate printout on paper or, where feasible, may be printed on the same sheet as the graphic display. Data shall be organized in a logical coherent display capable of periodic updating.
- c. Data shall include verbal activity descriptions with a numerical ordering system cross referenced to the graphic display. Additionally, costs (broken down into separate materials and labor costs), duration, early start date, early finish date, late start date, late finish date, and float shall be detailed for each activity. A running total of the percent completion based on completed activity costs versus total contract cost shall be indicated. A system for indicating scheduled versus actual activity dates and durations shall be provided.
- d. Schedule shall be of sufficient detail to facilitate the Contractor's control of the job and to allow the Contracting Officer to readily follow progress for portions of the work.

1.8 STATUS REPORT ON MATERIALS ORDERS

Within 15 days after notice to proceed, the Contractor shall submit, for approval by the Contracting Officer, an initial status report on materials orders. This report will be updated and re-submitted every 30 days as the status on material orders changes.

Report shall list, in chronological order by need date, materials orders necessary for completion of the contract. The following information will be required for each material order listed:

- a. Material name, supplier, and invoice number.

- b. Bar chart line item or CPM activity number affected by the order.
- c. Delivery date needed to allow directly and indirectly related work to be completed within the contract performance period.
- d. Current delivery date agreed on by supplier.
- e. When item d exceeds item c, the effect that delayed delivery date will have on contract completion date.
- f. When item d exceeds item c, a summary of efforts made by the Contractor to expedite the delayed delivery date to bring it in line with the needed delivery date, including efforts made to place the order (or subcontract) with other suppliers.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --



SECTION 09920

ARCHITECTURAL PAINTING

PART 1 GENERAL

1.1 REFERENCES

Not Used

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items. Data shall include detailed analysis of each coating material required, with constituents measured as percentages of the total weight of coating.

Inhibitive Metal Primer

Enamel Undercoat

Acrylic Latex
Acrylic Epoxy

SD-04 Samples

Manufacturer's Standard Color Charts shall be submitted in accordance with paragraph entitled, "Manufacturer's and Materials," of this section.

SD-07 Certificates

A Safety Plan shall be submitted in accordance with paragraph entitled, "General," of this section.

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for architectural coatings including details of thinning, mixing, handling, and application, in accordance with paragraph entitled, "General," of this section.

1.3 CONTRACTOR PERSONNEL QUALIFICATION

Personnel assigned to the work shall be certified by the Contractor to have had adequate previous experience in the successful application of paints and coatings similar to those specified.

1.4 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered in their original, unbroken containers bearing the manufacturer's name and product identification. Containers breached by rough handling shall be removed from the site, together with their contents.

Paint materials, thinners, and cleaners shall be stored in tightly closed containers in a covered, well-ventilated area where they will not be exposed to excessive heat, sparks, flame, or direct sunlight. Water-based materials shall be protected against freezing.

PART 2 PRODUCTS

2.1 MANUFACTURER'S AND MATERIALS

Manufacturer's Standard Color Charts shall be submitted showing manufacturer's recommended finish colors. Three color chips of each color and gloss scheduled shall also be submitted.

The following are suggested paint manufacturers and their products. Other paint manufacturers' products of equal quality will be considered when submitted and approved by the Contracting Officer.

<u>COATING</u>	<u>PITTSBURGH</u>	<u>SHERWIN WILLIAMS</u>	<u>GLIDDEN</u>
Inhibitive Metal Primer	6-712	B50WZ1	6970
Enamel Undercoat latex, flat	6-755 72 line	B49W2 A6 SERIES	300Acrylic 6500
Acrylic Latex, gloss	78 line	A8 SERIES	6600

PART 3 EXECUTION

3.1 GENERAL

A Safety Plan shall be submitted for architectural coating systems in accordance with OSHA regulations.

Manufacturer's recommendations for surface preparation, thinning, mixing, handling, and application shall be considered a part of this specification.

3.2 PROTECTION OF FACILITIES

Contractor shall remove and reinstall or provide acceptable protection for hardware, accessories, lighting and electrical components, factory-finished materials, plumbing fixtures and fittings, and any other materials that may become splattered or damaged by the painting work.

3.3 SURFACE PREPARATION

3.3.1 General Requirements

Surfaces shall be clean, dry, and free from contaminants and foreign matter. Mildew and chalking shall be removed and the surface thoroughly sterilized. Chipped, peeling, or blistered paint shall be removed and the surface spot primed. Hard glossy surfaces shall be dulled and roughened to ensure proper adhesion.

3.3.2 Ferrous Metal

Surfaces shall be free from dirt, oil, grease, wax, and other contaminants. Heavy rust and loose mill scale shall be removed by hand, power tool, or blast cleaning.

3.3.3 Galvanized Steel

Surfaces shall be cleaned of all contaminants using a solvent such as lacquer thinner or xylol.

After cleaning, the surface shall be etched with a phosphoric acid pre-treatment solution.

3.3.4 Aluminum

Surfaces shall be clean, dry, and free from oil and grease. Minor oxide film and corrosion shall be removed by hand or power tool cleaning.

3.3.5 Plaster and Drywall

Surfaces shall be clean and dry. Cracks and other surface imperfections shall be filled with spackling compound and sanded smooth.

3.4 MIXING AND APPLICATION

3.4.1 General Procedures

No exterior painting shall be allowed in rainy weather or when rain is imminent. No paints or coatings shall be applied when the temperature or humidity is outside the limits recommended by the manufacturer.

Paints and coatings shall be applied by brush, roller, or airless spray.

Each coat of material applied shall be free from runs, sags, bubbles, foreign contaminants, variations in color, gloss, and texture, dry overspray, brush and roller marks, holidays (missed areas), or other evidence of poor application.

Paints and coatings shall be thoroughly worked into corners and crevices.

Newly painted surfaces shall be adequately protected from damage.

3.4.2 Procedures

There shall be at least 3 coats of paint applied in accordance with the manufacturer's instructions.

Coatings shall be applied as follows:

Material shall be thoroughly stirred to produce a uniform mixture.

Material shall be thinned for workability and improved spray characteristics, but only according to the manufacturer's instructions.

Each coat shall be applied uniformly at the minimum wet-film thickness specified by the manufacturer.

Special attention shall be given when coating sharp edges, corners, and crevices to ensure complete coverage.

Finish coats shall show good hiding characteristics and uniform appearance.

3.5 ACCEPTANCE PROVISIONS

3.5.1 Inspection

Contractor shall provide qualified personnel for inspection of his work to ensure that the requirements of this section have been fulfilled.

3.5.2 Correction

Spot-painting to correct damaged surfaces will be allowed only when touchup area blends into the surrounding finish. Otherwise, the entire area shall be recoated. Touchup shall be accomplished using the same method of application as was used to apply the original material.

3.6 PROTECTION

"WET PAINT" signs shall be posted to indicate newly painted surfaces.

3.7 PAINT SCHEDULE

<u>SURFACE</u>	<u>PRIMER</u>	<u>UNDERCOAT AND FINISH COAT</u>	<u>FINISH COLOR AND SHEEN</u>
Interior drywall	Pigmented sealer	Water-base acrylic enamel	white flat
Interior metal	Inhibitive metal primer	Water-base acrylic enamel	white gloss

-- End of Section --

SECTION 16003

GENERAL ELECTRICAL PROVISIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M (2002) Standard Specification for Zinc
(Hot-Dip Galvanized) Coatings on Iron and
Steel Products

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2002) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA Z 535 (1991) Safety Color Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MS MIL-T-704 (Rev K) Treatment and Painting of Material

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS W-J-800 (Rev F) Junction Box: Extension, Junction
Box; Cover, Junction Box (Steel, Cadmium,
or Zinc-Coated)

UNDERWRITERS LABORATORIES (UL)

UL-05 (1995) Electrical Construction Materials
Directory

1.2 SUBMITTALS

Not Used

1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

It is the intent of these specifications and the contract drawings to provide a complete and workable facility.

Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements that may be required for proper installation of the work. Such work shall be verified at the site. Additional bends and offsets, and conduit as required by vertical and

horizontal equipment locations or other job conditions, shall be provided to complete the work at no additional cost to the Government.

Except where shown in dimensional detail, the locations of switches, receptacles, lights, motors, outlets, and other equipment shown on plans are approximate. Such items shall be placed to eliminate interference with ducts, piping, and equipment. Exact locations shall be determined in the field. Door swings shall be verified to ensure that light switches are properly located.

Equipment sizes indicated are minimum. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements and shall install wire, conduit, disconnect switches, motor starters, heaters, circuit breakers, and other items of the correct size for the equipment actually installed. Wire and conduit sizes shown on the drawings shall be taken as a minimum and shall not be reduced without written approval.

1.4 CODES AND STANDARDS

Equipment design, fabrication, testing, performance, and installation shall, unless shown or specified otherwise, comply with the applicable requirements of NFPA 70 and IEEE C2 to the extent indicated by the references.

1.5 COORDINATION

Installation of the electrical work shall be coordinated with the work of other trades.

1.6 APPROVAL REQUIREMENTS

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories (UL), Inc., the label of, or listing with re-examination, in UL-05 will be acceptable as sufficient evidence that the items conform to the requirements.

Where materials or equipment are specified to be constructed or tested in accordance with the standards of NEMA, ANSI, ASTM, or other recognized standards, a manufacturer's certificate of compliance indicating complete compliance of each item with the applicable NEMA, ANSI, ASTM, or other commercial standards specified will be acceptable as proof of compliance.

1.7 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall be given a rust-inhibiting treatment and the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09920 ARCHITECTURAL PAINTINGS. Aluminum shall not be used in contact with earth or concrete. Dissimilar metals in intimate contact shall be protected by approved fittings, barrier material, and treatment. Ferrous metals such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A 123/A 123M for exterior locations and cadmium-plated in conformance with FS W-J-800 for interior locations.

1.8 HAZARDOUS AREA

Electrical work within any hazardous location shall meet the applicable requirements of NFPA 70, Chapter 5, Articles 500 through 517. The following definitions apply:

Explosionproof: A receptacle, fixture, device, or equipment enclosure that is designed to withstand explosion of a specified liquid, gas, vapor, or dust within the enclosure and to prevent the ignition of a specified gas, vapor, or dust surrounding the enclosure by sparks, flashes, or explosions of the specified liquid, gas, vapor, or dust that may occur within the enclosure. Enclosure shall be capable of operating at an external temperature that will not ignite a surrounding flammable atmosphere.

Hazardous location: An area where ignitable vapors or dust may cause a fire or explosion created by energy emitted from lighting or other electrical equipment or by electrostatic generation.

NFPA 70, Article 500-2 lists chemical atmospheres by groups A, B, C, and D. In addition, although not defined as a hazardous material by the NEC, oxygen concentrations (liquid and gaseous) are considered to provide a hazard because of the increased flammability of materials exposed to oxygen. Therefore, oxygen concentrations shall be classified under Group D.

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES

Identification plates shall be 3-layer white-black-white, engraved to show black letters on a white background. Letters shall be uppercase. Identification plates 1-1/2 inches high and smaller shall be 1/16-inch thick with engraved lettering 1/8-inch high. Identification plates larger than 1-1/2 inches high shall be 1/8-inch thick with engraved lettering not less than 3/16-inch high. Identification plates having edges of 1-1/2 inches high and larger shall be beveled.

2.2 WARNING SIGNS

Each item of electrical equipment operating at 480 volts and above shall be provided with conspicuously located warning signs conforming to the requirements of Occupational Safety and Health Agency (OSHA) standards.

Any equipment with externally powered wiring shall be marked with a laminated plastic nameplate having 3/16-inch high white letters on a red background as follows:

DANGER - EXTERNAL VOLTAGE SOURCE

Safety color coding for identification of warning signs shall conform to NEMA Z 535.

2.3 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or slabs.

2.4 SEISMIC ANCHORAGE

Electrical equipment, except communications, emergency, and standby equipment, shall be anchored to withstand a lateral force of 0.3 times the weight of the equipment.

Communications, emergency, and standby equipment shall be anchored to withstand a lateral force of 0.6 times the weight of the equipment.

The following standard anchoring should be adequate for equipment not classified as communications, emergency, or standby:

Dry transformers - floor-mounted with four anchor bolts

BOLT DIAMETER

Under 150 kVA	-	3/8
150 to 500 kVA	-	1/2

Panels - floor-mounted with four 1/2-inch diameter anchor bolts

2.5 PAINTING

Enclosures of the following listed items shall be cleaned, primed, and factory-painted inside and outside in accordance with MS MIL-T-704. Refer to Section 09920 ARCHITECTURAL PAINTINGS, for requirement for outdoors or in harsh environments..

ITEM	FINISH COLOR
Circuit Breakers	ANSI No. 61 gray
Substations	ANSI No. 61 gray
Switchgear	ANSI No. 61 gray
Transformers	ANSI No. 61 gray
Safety Switches	Manufacturer's standard
Panelboards	Manufacturer's standard
Electric Heaters	Manufacturer's standard
Motors	Manufacturer's standard
Limit Switches	Manufacturer's standard
Control Components	Manufacturer's standard

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be accomplished by workers skilled in this type of work. Installation shall be made so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors. Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations.

3.2 PAINTING APPLICATION

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks, if not factory painted, shall be thoroughly cleaned and painted as specified in Section 09920 ARCHITECTURAL PAINTING unless otherwise noted. Work shall

be left in a neat and clean condition at final completion of the contract.

Emergency equipment, such as fire-alarm boxes, shall be cleaned, primed, and painted red.

3.3 IDENTIFICATION PLATE INSTALLATION

Identification plates shall be fastened by means of corrosion-resistant steel or nonferrous metal screws. Hand lettering, marking, or embossed self-adhesive tapes are not acceptable.

3.4 EQUIPMENT PADS

Equipment pads shall be constructed with a minimum 4-inch margin around the equipment and supports.

3.5 CUTTING AND PATCHING

Contractor shall install his work in such a manner and at such time as will require a minimum of cutting and patching on the building structure.

Holes in or through existing masonry walls and floors in exposed locations shall be drilled and smoothed by sanding. Use of a jackhammer will be permitted only where specifically approved.

3.6 DAMAGE TO WORK

Required repairs and replacement of damaged work shall be done as directed by and subject to the approval of the Contracting Officer, and at no additional cost to the Government.

3.7 CLEANING

Exposed surfaces of wireways, conduit systems, and equipment that have become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces are prepared for final finish or painting or are enclosed within the building structure.

Before final acceptance, electrical equipment, including lighting fixtures and glass, shall be clean and free from dirt, grease, and fingermarks.

3.8 FIELD TESTING AND TEST EQUIPMENT

All Field testing specified in Divisions 16 electrical specification shall be made with test equipment specially designed and calibrated for the purpose. Test equipment used shall be calibrated and certified by an approved testing laboratory. Date of last calibration and certification shall not be more than 90 days old at the time of field testing.

-- End of Section --



SECTION 16102

ELECTRICAL WORK

PART 1 GENERAL

1.1 REFERENCES

The following publications form a part of these specifications to the extent indicated by their references. The exclusion of a publication from this section will not relieve the Contractor from complying with the publication reference elsewhere.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C2	(2002) National Electrical Safety Code
ANSI C80.3	(1995) Electrical Metallic Tubing - Zinc-Coated

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2001a) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1998) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM D 1000	(1988) Standard Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 KN-m/cu. m))
ASTM D 3005	(1988) Standard Specification for Low Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

FEDERAL SPECIFICATIONS (FS)

FS J-C-30	(Rev B) Cable and Wire, Electrical (Power, Fixed Installation)
FS QQ-S-365	(Rev D) Silver Plating, Electrodeposited
FS W-B-30	(Rev A; Am 2) Ballast, Fluorescent Lamp
FS W-C-1094	(Rev A) Conduit and Conduit Fittings, Plastic, Rigid

FS W-C-375	(Rev B, Notice 1) Circuit Breakers, Molded Case; Branch Circuit and Service (General Specification)
FS W-C-586	(Rev D) Conduit Outlet Boxes, Bodies, and Entrance Caps, Electrical: Cast Metal
FS W-C-596	(Rev F; Supple 1; Am 1) Connector, Electrical Power
FS W-F-1234	(Rev A) Fixture, Lighting (Fluorescent Lamp, Industrial)
FS W-F-406	(Rev D) Fittings for Cable, Power, Electrical and Conduit, Metal, Flexible
FS W-F-408	(Rev E) Fittings for Conduit, Metal, Rigid (Thick-Wall and Thin-Wall (EMT) Type
FS W-F-414	(Rev E; Int Am 1) Fixture, Lighting (Fluorescent, Alternating Current, Pendant Mounting)
FS W-J-800	(Rev F) Junction Box: Extension, Junction Box; Cover, Junction Box (Steel Cadmium, or Zinc-Coated)
FS W-P-115	(Rev C) Panel, Power Distribution
FS W-S-610	(Rev E) Splice Connectors
FS W-S-896	(Rev E; Am 2; Notice 1) Switch, Toggle (Toggle and Lock), Flush Mounted (General Specification)
FS WW-C-566	(Rev C) Conduit, Metal, Flexible

FEDERAL STANDARDS (FED-STD)

FED-STD 595	(Rev B, Notice 1) Colors Used in Government Procurement
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INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-19-81	(1988; Rev 5, 6th Ed) Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
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INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.91	(1979) Standard Test Code for Dry-Type Distribution and Power Transformers
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MILITARY SPECIFICATIONS (MS)

MS MIL-T-704	(Rev K) Treatment and Painting of Material
MS MIL-I-19166C	Insulating Tape, Electrical, High-Temperature Glass Fiber, Pressure

Sensitive

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electric Equipment (1000 Volts Maximum)
NEMA ICS 1	(1993) Industrial Control and Systems, General Standards
NEMA KS 1	(1996) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA MG 1	(1998) Motors and Generators
NEMA PB 1	(1995) Panelboards
NEMA SG 3	(1995) Power Switching Equipment
NEMA ST 20	(1992) Dry-Type Transformers for General Applications
NEMA WD 1	(1999) General Requirements for Wiring Devices
NEMA Z 535	(1991) Safety Color Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2000) Life Safety Code
NFPA 54	(1999) National Fuel Gas Code
NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1	(2000) Flexible Metal Conduit
UL 6	(2000; 12 Ed) UL Standard for Safety for Electrical Rigid Metal Conduit
UL 20	(1995) UL Standard General-Use Snap Switches
UL 50	(1995; 11th Ed) UL Standard for Safety - Enclosures for Electrical Equipment
UL 508	(1999) Industrial Control Equipment
UL 510	(1994; Rev thru Apr 1998) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 514B	(1997; Rev Oct 1998) Standard for Safety Fittings for Cable and Conduit

UL 797	(1993; 6th Ed) UL Standard for Safety - Electrical Metallic Tubing
UL 870	(1995; 7th Ed) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings
UL 94	(1991) Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances Fourth Edition, August 19, 1992
UL 924	(1995; Rev thru Oct 97) Emergency Lighting and Power Equipment
UL 1571	(1995; Rev thru Nov 1999) Incandescent Lighting Fixtures
UL 1572	(1995; Rev thru Nov 1999) High Intensity Discharge Lighting Fixtures

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330,
"Submittals":

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for the
following in accordance with the paragraph entitled, "General
Requirements," of this section.

- Panelboards and Electrical Enclosures
- Switchboards
- Dry-Type Distribution Transformers
- Motors
- Motor Controllers
- Lamps and Lighting Fixtures
- Metering Equipment

SD-02 Shop Drawings

Connection Diagrams shall be submitted for the following in
accordance with the paragraph entitled, "Connection Diagrams," of
this section.

- Safety Switches
- Switchboards

- Dry-Type Distribution Transformers
- Motors
- Motor Controllers
- Lamp and Lighting Fixtures
- Metering Equipment

SD-02 Shop Drawings

Elementary Diagrams shall be submitted for the following in accordance with the paragraph entitled, "Elementary Diagrams," of this section.

Switchboards

Dry-Type Distribution Transformers

Motors

Metering Equipment

SD-02 Shop Drawings

Schematics shall be submitted for the following in accordance with the paragraph entitled, "Schematics," of this section.

Switchboards

Signal System Cabinets

Dry-Type Distribution Transformers

Motors

Metering Equipment

SD-02 Shop Drawings

Coordination Drawings shall be submitted in accordance with the paragraph entitled, "Coordination Drawings," of this section.

Underground Conduit Layout shall be in accordance with paragraph entitled, "Conduit System" of this section.

SD-02 Shop Drawings

Outline Drawings shall be submitted for the following in accordance with the paragraph entitled, "Outline Drawings," of this section.

Wireways and Auxiliary Gutter

Panelboards and Electrical Enclosures

Switchboards

Dry-Type Distribution Transformers

Motors

SD-02 Shop Drawings

As-Built Drawings, shall be submitted for the following in accordance with the paragraph entitled, "As-Built Drawings," of this section.

Connections Diagrams

Elementary Diagrams

Schematics

Detail Drawings

Outline Drawings

SD-03 Product Data

Equipment and Performance Data shall be submitted for the following in accordance with the paragraph entitled, "Equipment and Performance Data," of this section.

- Motors
- Dry-Type Distribution Transformers
- Motor Controllers
- Circuit Breakers
- Switchboards

SD-03 Product Data

Manufacturer's Catalog Data (catalog cuts, brochures, circulars, specifications, product data, and other printed information) showing in sufficient detail and scope to verify compliance with the requirements of the contract documents shall be submitted for the following:

Wireways and Auxiliary Gutter

- Wire and Cable
- Connectors
- Tape
- Safety Switches
- Wall Switches
- Receptacles
- Device Plates
- Outlets, Outlet Boxes, and Pull Boxes
- Panelboards and Electrical Enclosures
- Switchboards
- Circuit Breakers

- Dry-Type Distribution Transformers
- Motors
- Motor Controllers
- Lamp and Lighting Fixtures
- Cable Splices
- Metering Equipment

Underground Warning Tape

SD-03 Product Data

Spare Parts Data shall be submitted for the following in accordance with the paragraph entitled, "Spare Parts Data," of this section.

- Motors
- Dry-Type Distribution Transformers
- Switchboards

SD-06 Test Reports

Test Reports shall be submitted for the following in accordance with the paragraph entitled, "FIELD TESTING" of this section:

Conductor Insulation

Circuit Breakers

SD-06 Test Reports

Insulation Resistance Test

SD-07 Certificates

Safety Considerations shall be submitted for the following in accordance with the paragraph entitled, "Safety Considerations," of this section.

Switchboards
Dry-Type Distribution Transformers
Motors

SD-07 Certificates

Parts List shall be submitted for the following in accordance with the paragraph entitled, "Parts List," of this section.

Switchboards

SD-07 Certificates

Special Tools and Test Equipment shall be submitted for the following in accordance with the paragraph entitled, "Special Tools and Test Equipment," of this section.

Switchboards
Dry-Type Distribution Transformers
Motors

SD-08 Manufacturer's Instructions

Preventative Maintenance and Inspection shall be submitted for the following in accordance with the paragraph entitled, "Preventative Maintenance and Inspection," of this section.

Switchboards

SD-08 Manufacturer's Instructions

Repair Procedures shall be submitted for the following in accordance with the paragraph entitled, "Repair Procedures," of this section.

Switchboards

SD-08 Manufacturer's Instructions

Posted Instructions shall be submitted for the following in

accordance with the paragraph entitled, "Posted Instructions," of this section.

Switchboards

SD-08 Manufacturer's Instructions

Manufacturer's Instructions showing the manufacturer's recommended method and sequence of installation, shall be submitted for the following:

Panelboards and Electrical Enclosures
Switchboards
Circuit Breakers

Motor Controllers

Cable Splices
Metering Equipment

Vibration Damping Pad

SD-10 Operation and Maintenance Data

Operation and Maintenance Data shall be submitted for the following in accordance with the paragraph entitled, "Operation and Maintenance Data," of this section.

Switchboards
Dry-Type Distribution Transformers
Motors

1.3 GENERAL REQUIREMENTS

Material, Equipment, and Fixture Lists, including the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabricate site information shall be submitted for Panelboards and Electrical Enclosures, Switchboards, Dry-Type Distribution Transformers, Motors, Motor Controllers, Lamp and Lighting Fixtures, and Metering Equipment.

The electrical systems shall be provided as indicated and shall include the following:

Electrical service

Power-distribution system

Lighting system

Bonding and grounding systems

Wireways, cabinets, and outlets for signal systems

Fire Alarm System

1.4 QUALITY ASSURANCE

Approval of materials and equipment will be based on the manufacturer's published data. Proof that the items furnished conform to the specified requirements as indicated below shall be submitted for approval.

Where material and equipment are specified to conform to the standards of the Underwriters' Laboratories (UL), Inc., the UL label or listing will be acceptable as sufficient evidence that the items conform to requirements. In lieu of such label, or listing, the Contractor may submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that they conform to the UL requirements including methods of testing.

Where materials or equipment are specified to be constructed or tested, in accordance with the standards of NEMA, ANSI, ASTM, or other commercial standard, a manufacturer's certificate indicating complete compliance of each item with the applicable NEMA, ANSI, ASTM, or other commercial standard specified, will be acceptable as proof of compliance.

Equipment design, fabrication, testing, performance, and installation shall, unless shown otherwise, comply with the applicable requirements of NFPA 70 (the NEC), ANSI C2, and referenced industrial codes and standards.

1.5 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

It is the intent of these specifications and the contract drawings to provide a complete and workable facility.

Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements which may be required for proper installation of the work. Such work shall be accomplished at the site. Additional bends, offsets, and conduit as required by vertical and horizontal equipment locations or other job conditions shall be provided to complete the work at no additional cost to the Government.

Except where shown in dimensional detail, the locations of switches, receptacles, lights, motors, outlets, and other equipment shown on plans are approximate. Such items shall be placed so as to eliminate interference with ducts, piping, and equipment. The exact location shall be determined in the field. All door swings shall be verified so that light switches are properly located.

Equipment sizes shown on the drawings are minimum unless otherwise indicated. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements and install wire, conduit, disconnect switches, motor starters, heaters, circuit breakers, and other items of the correct size for the equipment actually installed; however, wire and conduit sizes shown on the drawings shall be taken as a minimum and shall not be reduced without written approval.

1.6 INSPECTIONS

Work shall not be covered up nor enclosed until it has been inspected, tested, and approved. Any work that is enclosed or covered up before such inspection and test shall be uncovered and, after it has been inspected and approved, shall be restored to its original condition at no additional cost

to the Government.

1.7 COORDINATION

The electrical work shall be coordinated with the work of all other trades. Coordination shall include adequate clearances for the installation and maintenance of equipment and physical and electrical requirements of items or equipment requiring connections.

When it is necessary to coordinate with work of other trades, Contractor shall provide electrical service, extend conduits, and make all necessary connections as required to minimize interruption of service in any area.

1.8 STORAGE AND PRESERVATION OF MATERIALS AND EQUIPMENT

Equipment and materials stored at the site, prior to final installation, shall be fully protected from damage, dirt, debris, and weather.

Equipment provided with a factory finish shall be fully protected during construction and shall be maintained free of dust, dirt, and foreign matter. Dents, marred finishes, and other damaged equipment shall be repaired to its original condition or replaced.

1.9 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall be given a rust-inhibiting treatment and the standard finish by manufacturer when used for most indoor installations. Aluminum shall not be used in contact with earth or concrete and, where connected to dissimilar metal, shall be protected by approved fittings and treatment.

Ferrous metals such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel shall be hot-dip galvanized in accordance with ASTM A 123/A 123M or ASTM A 153/A 153M except where other equivalent protective treatment is specifically approved in writing for exterior locations and cadmium-plated in conformance with FS W-J-800 for interior locations.

1.10 CONNECTION DIAGRAMS

Connection Diagrams indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring and other devices, shall be submitted for Safety Switches, Switchboards, Signal System Cabinets, Dry-Type Distribution Transformers, Motors, Motor Controllers, Lamp and Lighting Fixtures, Metering Equipment, Fluorescent Dimming System, and Incandescent Dimming System.

1.11 ELEMENTARY DIAGRAMS

Elementary Diagrams indicating in straight-line form and without regard for physical relationship, supporting systems and elements of equipment and associated apparatus, shall be submitted for Switchboards, Signal System Cabinets, Dry-Type Distribution Transformers, Motors, Metering Equipment, Fluorescent Dimming System, and Incandescent Dimming System. Items shall be clearly labeled to indicate rates and use in the system.

1.12 SCHEMATICS

Schematics depicting the functional flow of systems and their interfaces with facilities and other systems, shall be submitted for Switchboards, Signal System Cabinets, Dry-Type Distribution Transformers, Motors, Metering Equipment, Fluorescent Dimming System, and Incandescent Dimming System. Schematics need not be to scale.

1.13 COORDINATION DRAWINGS

Coordination Drawings showing coordination of work of one trade with that of other trades and with the structural and architectural elements of the work, shall be submitted. Drawings shall be in sufficient detail to show overall dimensions of related items clearances, and relative locations of work in allotted spaces. Drawings shall indicate where conflicts or clearance problems exist between the various trades.

1.14 OUTLINE DRAWINGS

Outline Drawings indicating overall physical features, dimensions, ratings, service requirements, and weights of equipment, shall be submitted for Conduit and Tubing Wireways and Auxiliary Gutter, Surface Metal Raceways, Cable Trays, Panelboards and Electrical Enclosures, Switchboards, Signal System Cabinets, Dry-Type Distribution Transformers, and Motors.

1.15 AS-BUILT DRAWINGS

As-Built Drawings providing factual information, including deviations from and amendments to the drawings and concealed and visible changes in the work, shall be submitted for Connections Diagrams, Elementary Diagrams, Schematics, Detail Drawings, and Outline Drawings.

1.16 EQUIPMENT AND PERFORMANCE DATA

Equipment and Performance Data providing information on use life, system functional flows, safety features, mechanical automated details, automatic interlocks, and such features as electrical system protective devices ratings, as well as curves indicating tested and certified equipment response and performance characteristics shall be submitted for Motors, Dry-Type Distribution Transformers, Motor Controllers, Circuit Breakers, and Switchboards.

1.17 SAFETY CONSIDERATIONS

Safety Considerations including information relating to load limits, speed of operation, environmental criteria (temperature and pressure limitations), and personnel hazards and equipment safety precautions, shall be submitted for Switchboards, Dry-Type Distribution Transformers, and Motors.

1.18 SPARE PARTS DATA

Spare Parts Data includes a complete list of parts and supplies with current unit prices and source of supply for Motors, Dry-Type Distribution Transformers, and Switchboards. Also, list parts and supplies that are either normally furnished at not extra cost with the purchase of equipment, or specified to be furnished as a part of the Contract, and list additional items recommended by the manufacturer to ensure an efficient operation for a period of 120 days.

1.19 PARTS LIST

Parts List listing by manufacturer's name, part number, nomenclature, and stock, level required for maintenance and repair necessary to ensure continued operation with minimal delay, shall be submitted for Switchboards, Dry-Type Distribution Transformers, and Motors.

1.20 SPECIAL TOOLS AND TEST EQUIPMENT

Special Tools and Test Equipment shall be submitted for Switchboards, Dry-Type Distribution Transformers, and Motors required for maintenance and testing purposes.

1.21 PREVENTATIVE MAINTENANCE AND INSPECTION

Preventative Maintenance and Inspection procedures shall include frequency of preventative maintenance, inspection, adjustment, lubrication, and cleaning necessary to minimize corrective maintenance and repair for Switchboards, Dry-Type Distribution Transformers, and Motors.

1.22 REPAIR PROCEDURES

Provide Repair Procedures to checkout, troubleshoot, repair, and replace components of the equipment or system for Switchboards, Dry-Type Distribution Transformers, and Motors. The procedures shall include manufacturer's integrated electrical schematics and diagrams, and diagnostic techniques necessary to totally troubleshoot the mechanical, electrical, electronic, and pneumatic component or system.

1.23 POSTED INSTRUCTIONSS

Posted Instructions including labels, and templates of operating instructions that are required to be mounted or installed on or near the product for normal, safe operation, shall be submitted for Switchboards and Dry-Type Distribution Transformers.

1.24 OPERATION AND MAINTENANCE DATA

The Contractor shall provide six (6) up-to-date final asbuilt copies of the Operation and Maintenance Manuals as specified in JSC Submaster Section 01330, "Submittals".

O&M Manuals will be submitted for Switchboards, Dry-Type Distribution Transformers, and Motors.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products. Materials and equipment shall meet the specified requirements, the detailed requirements indicated, be suitable for the installation shown, and shall represent products that have been in satisfactory use at least two years. Products not meeting all specified requirements will not be accepted.

Where two or more units of the same equipment class are furnished, the equipment shall be from the same manufacturer and shall be interchangeable.

Equipment and materials shall be new, and free from defects.

2.2 IDENTIFICATION PLATES

In addition to manufacturer's standard identification plates, engraved laminated phenolic identification plates shall be provided for each motor starter, cabinet, panelboard, transformer, and each piece of electrical equipment provided under this contract. Identification plates shall designate the function of the equipment for which used and the source of power for the equipment. The designation shall be submitted for approval with the shop drawings.

Identification plates shall be 3-layer white-black-white, engraved to show white letters on a black background. Letters shall be uppercase. Identification plates 1-1/2-inches high and smaller shall be 1/16-inch thick with engraved lettering 1/8-inch high. Identification plates larger than 1-1/2-inches high shall be 1/8-inch thick with engraved lettering not less than 3/16-inch high. Edges of 1-1/2-inch high and larger identification plates shall be beveled. Nameplates shall be attached with machine screws in tapped holes.

2.3 CONDUIT AND RACEWAYS

2.3.1 Rigid Steel Conduit

Rigid steel conduit shall conform to UL 6. Conduit fittings shall conform to FS W-F-406 and FS W-F-408.

2.3.2 Rigid Plastic (PVC) Conduit

PVC conduit shall not be lighter than Schedule 40. Rigid PVC shall be the slip-joint solvent-weld type, and all fittings shall be unthreaded solid PVC. Conduit and fittings shall conform to FS W-C-1094.

2.3.3 Electrical Metallic Tubing (EMT)

EMT shall be rigid metallic conduit of the thin wall type in straight lengths, elbows, or bends and shall conform to ANSI C80.3 and the requirements of UL 797.

Couplings and connectors shall be hex-nut expansion-gland compression type, with insulating throat, zinc- or cadmium-plated. Crimp, spring, or set-screw type fittings are not acceptable. Where EMT enters outlet boxes, cabinets, or other enclosures, connectors shall be the insulated-throat type, with a locknut. Fittings shall meet the requirements of FS W-F-408.

2.3.4 Flexible Metallic Conduit

Flexible metallic conduit shall meet the requirements of FS WW-C-566 and UL 1.

Liquidtight flexible metallic conduit shall be provided with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

Fittings for flexible metallic conduit shall meet the requirements of FS W-F-406, Types I (box connector, electrical), III (coupling, electrical conduit, flexible steel), or IV (adapter, electrical conduit), class and style as required.

Fittings for liquidtight flexible metallic conduit shall meet the requirements of FS W-F-406, Type I (box connector, electrical), Class 3 (liquidtight flexible metallic conduit connectors), style as required.

2.4 WIRING AND CABLE - 600-VOLT AND LESS

Thermoplastic-insulated wire and cable shall conform to FS J-C-30.

Flexible cable shall conform to FS J-C-30 Type SO or ICEA S-19-81, and shall contain a ground conductor with green insulation.

2.5 CONNECTORS

Wire pressure connectors and conductor splices shall conform to FS W-S-610.

2.6 TAPE

2.6.1 Fire and Electrical Arc Proofing Tape

The fire and arc proofing tape shall be designed to protect all types of electrical cables. The tape shall consist of a flexible conformable unsupported intumescent elastomer. The tape shall be not less than 0.030 inch thick per ASTM D 1000, have a tensile strength of 1,500 pounds per square inch per ASTM D 1000, have a flame resistance of V-0 per UL 94, and be capable of over 100 percent elongation. The tape shall be non-corrosive to metallic cable sheaths and compatible with synthetic cable jackets (i.e. semi-conducting URD type, polyethylene, P.V.C., etc.). The tape shall be self-extinguishing and shall not support combustion. The tape shall not deteriorate when subject to water, salt water, gases and sewage. The fireproofing tape shall be capable of withstanding a high current (60 Hz) fault arc temperature of 13,000 degrees Kelvin for 70 cycles. The color of the tape shall be black.

2.6.2 Vinyl Plastic Electrical Tape

The vinyl plastic electrical tape shall be 8.5 mils thick per ASTM D 1000, heavy duty, all weather vinyl plastic insulating tape. The tape shall be UL listed, and shall meet the requirements of UL 510 and ASTM D 3005 Type II. The tape shall have a polyvinyl chloride (PVC) backing, and shall have a pressure-sensitive rubber-based adhesive. The tape shall be compatible with solid dielectric cable insulations, and shall be compatible with rubber and synthetic splicing compounds as well as epoxy and polyurethane resins. The tape shall inhibit corrosion of electrical conductors. The tape shall be suitable for both indoor and outdoor applications. The tape shall be marked per UL 510 as flame retardant, cold and weather resistant. The tape must be applicable at temperatures ranging from 0 degrees F through 100 degrees F without loss of physical or electrical properties. The voltage rating of the tape shall be 600 volts per UL 510.

2.6.3 Glass Cloth Electrical Tape

The glass cloth electrical tape shall be 7.5 mils per ASTM D 1000 with a thermosetting silicon adhesive. The tape shall have a minimum tensile strength of 150 pounds per square inch per ASTM D 1000. The tape shall have a Class "H" (180 degrees C) temperature rating. The tape shall conform to MS MIL-I-19166C, and shall be UL listed. The tape shall have an insulation resistance of 250 megohms at 96 percent relative humidity per

ASTM D 1000, and an electrical strength of 3,500 volts per ASTM D 1000.

2.7 SAFETY SWITCHES

Switches shall comply with NEMA KS 1.

Safety switches shall be the heavy-duty type with voltage, current rating, number of poles, and fusing as shown on the contract drawings. Switch construction shall be such that, with the switch handle in the ON position, the cover or door cannot be opened. The cover release device shall be coinproof and shall be so constructed that an external tool (screwdriver) must be used to open the cover. Provisions shall be made to lock the handle in the OFF position, but the switch handle shall not be capable of being locked in the ON position.

Switches shall be the quick-make, quick-break type. Terminal lugs shall be approved for use with copper conductors.

2.8 WALL SWITCHES

Snap switches installed for the control of incandescent, mercury, and fluorescent lighting fixtures shall be heavy-duty general-purpose noninterchangeable flush devices conforming to UL 20 and NEMA WD 1, as indicated and specified.

Snap switches shall be the specification grade toggle type: single-pole, double-pole, three-way, and four-way two-position devices rated 20 amperes at 277 volts, 60 hertz, ac only, meeting the requirements of FS W-S-896.

All snap switches shall be made by the same manufacturer.

Where two or more snap switches are to be installed at the same location, they shall be mounted in one-piece ganged switch boxes, with a gang cover plate.

Combination snap switch and single or duplex receptacles shall be mounted in two-gang switch boxes, with a combination two-gang cover plate.

Combination snap switch and flush pilot light shall be interchangeable devices mounted in a one-gang switch box with a one-gang two-opening cover plate. The pilot-light cover opening shall be fitted with a rectangular-shaped ruby-red plastic jewel in a metal frame.

2.9 RECEPTACLES

Duplex receptacles shall be 5-20R configuration in NEMA WD 1 and conforming to FS W-C-596.

Special-purpose receptacles shall be as indicated.

2.10 DEVICE PLATES

Device plates shall be one piece to suit the devices installed. Plates shall be stainless steel 0.035 inches thick.

2.11 OUTLETS, OUTLET BOXES, AND PULL BOXES

Sheetmetal boxes shall conform to FS W-J-800.

Castmetal boxes shall conform to FS W-C-586.

Outlets, outlet boxes, and pull boxes shall have sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NFPA 70 (the NEC), Article 370. Boxes exposed to the weather or mounted in normally wet locations or locations susceptible to physical damage (surface mounted) shall be the cast-metal type with threaded hubs and gasketed covers. Boxes in other areas shall be cadmium-plated or zinc-coated sheetmetal. Outlet boxes for use with conduit systems shall be not less than 1-1/2 inches deep and 4 inches by 4 inches. Pull and junction boxes shall be furnished with screw-fastened covers. Boxes mounted on surface mounted wireway under computer flooring shall be a minimum of 2-1/8 inches deep. Fittings shall conform to UL 514B.

Pull and splice boxes for power conductors (feeders) which are specifically detailed and described on the drawing shall be of the type specified and shall be no smaller than the dimensions indicated. The boxes shall be large enough to perform their intended function (i.e., pulling point, cable splicing, etc.).

2.12 PANELBOARDS AND ELECTRICAL ENCLOSURES

2.12.1 Panelboards

Panelboards shall conform to FS W-P-115 and NEMA PB 1. Lighting and appliance branch circuit panelboards shall be the circuit-breaker type. Circuit-breaker interrupting ratings shall be not less than indicated and in no event less than 10,000 root mean square symmetrical ac amperes and 5,000 dc amperes. Multipole circuit breakers shall be the common-trip type with a single handle. Circuit breakers shall be capable of being, pad locked in the open position. All circuit breakers shall be bolted to the bus; plug-in circuit breakers are not acceptable. Buses shall be copper of the rating indicated, with main lugs or main circuit breaker as indicated. Panelboards for use on grounded ac systems shall be provided with a full-capacity isolated neutral bus, and all panelboards shall be provided with a separate grounding bus bonded to the panelboard enclosure. Panelboard enclosures shall be NEMA 250, Type 1 unless otherwise indicated, and enclosure fronts shall have hinged doors lockable with pin-tumbler locks. All locks shall be common keyed, and two keys shall be provided with each panelboard.

2.12.2 Circuit Arrangement

The circuit arrangement shall be as indicated and all circuits shall be numbered serially from top to bottom with odd-numbered circuits in vertical configuration of the left side of the panel and the even-numbered circuits in a vertical configuration on the right side of the panel. Any deviation of circuit breaker arrangement from that which is indicated will not be accepted. Where panel schedules indicate spaces for future breakers, all necessary hardware (bus clips, etc.) shall be provided for such spaces.

2.12.3 Electrical Enclosures

Each electrical enclosure shall be flush or surface-mounted as indicated, with the enclosure consisting of a code-gauge zinc-coated sheet steel box. The cabinet rim shall be manufactured from one piece of full finish sheet steel (not zinc-coated). The cabinet shall be given the manufacturer's standard commercial finish. The cabinet shall be of sufficient size to allow code-size cutter space on all sides around the panelboard. The

cabinet rim shall be fastened to the cabinet by means of screws. Minimum depth of enclosure shall be in accordance with the NEC or as indicated.

2.12.4 Indices

The inside of the panel door shall be equipped with a card holder and a typewritten index card identifying each circuit as installed.

2.13 SWITCHBOARDS

Switchboards shall conform to NEMA SG 5. Switchboards shall be the metal-enclosed, free standing, general purpose type with copper buses, metering equipment, and circuit breakers as indicated. Circuit breaker interrupting ratings and bus bracing shall be suitable for the available fault current. Auxiliary equipment shall be provided as indicated.

2.14 CIRCUIT BREAKERS

Specification Section 16286, "Overcurrent Protective Devices", also applies to this part.

Molded-case circuit breakers shall conform to FS W-C-375.

Low-voltage draw-out power circuit breakers shall conform to NEMA SG 3.

Circuit breakers shall have the minimum interrupting ratings indicated. All molded case circuit breakers shall have bolted connections to the bus.

2.15 DRY-TYPE DISTRIBUTION TRANSFORMERS

General-purpose dry-type transformers for connections to low-voltage distribution circuits 600 volts or less and the supply of lighting and power loads shall be two-winding, 60-hertz, self-contained, self-cooled in accordance with Part 2 of NEMA ST 20, as indicated and herein specified.

Transformers with output ratings 30 kVA and above shall have Class H, 80 degree C temperature rise, insulation and be housed in ventilated sheetmetal enclosures designed for floor or wall mounting. All single- and three-phase transformers of this size shall be equipped with six 2-1/2 percent primary taps (two full-capacity taps above normal and four full-capacity taps below normal).

Transformers with output ratings below 30 kVA shall be the nonventilated type with Class B, 80 degree C temperature rise, insulation and be designed for wall mounting. All single- and three-phase transformers of this size shall be equipped with four 2-1/2 percent primary full-capacity taps below normal.

Windings shall be copper. Primary and secondary coil-winding terminals shall be brought out to a terminal block located in the wiring compartment at the bottom of the enclosure. Manual tap-changing connections shall be accessible in wiring compartment for nonventilated transformers and in wiring compartment or coil face within ventilated transformer enclosures. Wiring compartment shall be provided with removable access cover and knock-outs for bottom and side conduit connections. Lifting facilities shall be provided for the handling and installation of equipment. Provision shall be made for grounding the transformer enclosure and the neutral point in the secondary winding to the building grounding system.

Transformer kVA ratings are continuous and shall be based on temperature rise. Temperature limits shall not be exceeded when the transformer is delivering rated kVA output at rated secondary voltage.

Transformers shall be capable of withstanding without injury the mechanical and thermal stresses caused by short circuits on the external terminals of the low-voltage windings. Transformers with sound levels greater than 45 dB shall be installed on resilient vibration-isolating mounting to prevent amplification of sound. Audible sound level tests shall be made in accordance with IEEE C57.12.91 except that transformers shall be the quiet type with the average sound level not exceeding the following:

<u>TRANSFORMER RATING, kVA</u>	<u>AVERAGE SOUND LEVEL, dB</u>
0 to 9	40
10 to 50	45
51 to 150	50
151 to 300	55

2.16 MOTORS

2.16.1 General

Fractional and integral horsepower motors shall conform to NEMA MG 1.

Motor controls shall conform to NEMA ICS 1 and UL 508.

Except where different requirements are specified in sections in which the motor-driven equipment is specified, motors shall conform to the requirements of this section. In case of conflict, requirements in sections in which the driven equipment is specified shall take precedence over the requirements of this section.

2.16.2 Motors

Motors shall be a sufficient size for the duty to be performed and shall not exceed the full rated load of the motor when the driven equipment is operating at specified capacity under the most severe conditions likely to be encountered. Unless otherwise specified, all motors shall be UL listed, open, drip-proof type, Class F or better insulation, and continuous-duty classification based on a 104 degree F ambient temperature of reference. Polyphase motors shall be Type II, Design B, squirrel-cage type having normal-starting torque and low-starting current characteristics, unless other characteristics are specified elsewhere. When electrically driven equipment furnished under other sections of these specifications materially differs from the contemplated design, the necessary adjustments to the wiring, disconnect devices, and branch-circuit protection shall be made to accommodate the equipment actually installed. Each motor shall be provided with controls as indicated. Control voltage for starters, contactors, relays, and other control devices shall be 120 volts, 60 hertz. Each 480-volt magnetic starter shall be provided with an individual fused control transformer to obtain the 120-volt control circuit.

2.16.3 Motor Protection

Each motor of 1/8-horsepower or larger shall be provided with thermal-overload protection. The overload-protection device shall be provided either integral with the motor or controller. Unless otherwise specified, the protective device shall be of the manual-reset type. All 3 phase motor controllers shall provide overload protection and a set of contacts in each phase. The overload-relay heater elements shall be the size recommended by the manufacturer for the full-load rated current of the motor.

2.17 MOTOR CONTROLLERS

2.17.1 General

Each motor shall be provided with a suitable controller and devices that will perform the functions required for each motor.

All controllers shall conform to the adopted standards and recommended practices of UL 508, and NEMA ICS 1.

2.17.2 Circuits

All motor-control circuits shall operate at 120 volts. Control-circuitry power shall be obtained from the load side of the motor-disconnect means, from a 2-wire, 120 volts grounded circuit obtaining its source from the same circuit feeding the motor. If the motor circuit is more than 120 volts to ground, the control circuit shall be energized from a 2-winding transformer having its 120 volts secondary winding grounded. Overcurrent protection shall be provided in the ungrounded primary and secondary conductor and shall be the size recommended by the manufacturer of the motor.

2.17.3 Automatic Controllers

Automatic control devices such as thermostats or float or pressure switches may directly control the starting and stopping of single phase motors up to 1/4 horsepower, provided the devices used are designed for the purpose and have an adequate horsepower rating. When the automatic control device does not have such a rating, a magnetic starter shall be used, with the automatic control device actuating the pilot control circuit.

2.17.4 Manual Controllers

Manual controllers shall be toggle type, 120/240 volts AC, 1 horsepower maximum, complete with overload relay, in NEMA 1 enclosure. The starter shall be provided with a toggle-locking attachment. The overload relay heater element shall be the size recommended by the manufacturer for the full load rated current of each motor.

2.17.5 Manual-and-Automatic Controllers

When combination manual-and-automatic control is specified, and the automatic-control device operates the motor directly, a double-throw, 3-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot-control circuit of a magnetic starter, the latter shall be provided with a 3-position selector switch marked "manual-off-automatic". Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the "manual"

position; all safety control devices such as low- or high-pressure cutout, high-temperature cutout, and motor-overload protective devices shall be connected in the motor-control circuit in both the "manual" and the "automatic" positions of the selector switch.

2.17.6 Magnetic Motor Starters

Magnetic motor starters shall be the full-voltage across-the-line type, with NEMA size, voltage, and number of phases as noted on the contract drawings. The operating coil shall be rated for 120 volts AC. Starters shall be installed in NEMA 1 enclosures except where NEMA 3R, or NEMA 4, are shown on the contract drawings.

2.18 LAMPS AND LIGHTING FIXTURES

2.18.1 Fluorescent

Industrial fluorescent fixtures shall conform to FS W-F-1234.

All fluorescent lamps shall be the high efficiency (34 or 35 watt, 425 mA) rapid-start type unless otherwise specified.

Ballasts shall conform to FS W-B-30.

Manufacturers and catalog numbers shown are indicative of the general type desired and are not intended to restrict the selection to fixtures of any particular manufacturer. Fixtures with the same salient features and equivalent light distribution and brightness characteristics, of equal finish and quality, will be acceptable as approved by the Contracting Officer. All fluorescent fixtures shall have a radio interference (rfi) filter similar to GE 89G635.

Ballasts shall be high power factor, low-energy type, UL listed and CBM certified by Electrical Testing Laboratories. Ballasts shall be Class P for 120- or 277-volt operation as indicated and shall be rapid-start energy efficient type. Ballasts shall be A sound rated. Ballasts shall be equipped with integral thermal circuit opening protection devices. Ballasts shall be solid-state type.

Energy-efficient solid-state ballasts shall not use capacitors containing polychlorinated biphenyls (PCB's).

Solid-state ballast shall allow a 90 to 110 percent voltage variation with a typical 0.9 leading power factor. This type of ballast shall have a mean time between failures (MTBF) of 30,000 hours, and shall have no third harmonic generation.

Solid-state ballasts shall be interchangeable with conventional ballast.

2.18.2 Incandescent

Incandescent fixtures shall conform to UL 1571.

2.18.3 Emergency and Exit

Emergency and exit lighting fixtures shall conform to UL 924. Emergency lighting luminaires shall be in accordance with FS W-L-305. Exit lights

shall be as specified in NFPA 101.

2.19 25 kV CABLE SPLICES

2.19.1 Universal Demountable Splicing Systems

25-kV universal demountable splicing systems, G&W Electric Co., type "CE-CE" and "CE-CE-CE", or equal, shall be provided for manhole cable splices.

Contractor shall verify exact cable data including conductor material, conductor shape, conductor size, insulation material, insulation O.D. in inches, shield type, and jacket O.D. prior to ordering splicing components.

Cable and universal demountable splice components shall include gasketed end sealing caps, end cap mounting bolts, tinned connector spacers, metal shielded epoxy splice bodies, copper or plated aluminum compression type connectors, corona free molded silicone rubber stress cones, silicone bronze or stainless steel entrance body assemblies, U-bolt grounding assemblies and grounding hardware for a continuous end to end bonding/grounding system.

Molded rubber sealing boots shall be provided for waterproof seal between cable and 1/C splice entrance assemblies.

3M Brand, or equal, pre-stretched 3/C trifurcating boot cable seals with three cable cold shrink sealing tubes shall be provided at each cable splice termination to prevent moisture penetration or contamination to the outer sheath termination of multicore cables and 1/C cable splice entrances.

All splices shall be staggered so as to minimize, wall, and ceiling congestion except where existing cable lengths at buildings are too short to accommodate splice staggering. At the "Short Cable" locations the splice elements (CE-CE or equal) shall be racked and supported individually.

2.19.2 Inline Tape Splice

15-kV permanent inline tape splices as indicated may be used at the Contractor's option to facilitate cable lengths and installation of power cable within the Utility Tunnel. Taped splices shall not be used at any location where universal demountable splicing systems are indicated.

Shielded cable inline "Scotch" taped splices as recommended by cable manufacturer for power cable specified or other approved inline splicing methods shall be provided.

2.19.3 Cable Connectors

Cable connectors shall be UL approved for the locations and conditions encountered. Connectors shall be sized for the specific cable to which they will be installed. Connectors accepting a range of cable sizes will not be acceptable. Connectors shall be capable of being crimped using a T&B crimping die.

2.19.4 Warning and Identification Signs

Warning and identification signs shall be self-sticking, all vinyl cloth, pressure-sensitive labels conforming to NEMA Z 535

The Contractor shall provide warning signs on each side of new cable splices and at minimum intervals of 50 feet along the length of the cable. New signs shall be 7/8 inch high black letters on alert orange background and shall read "CAUTION", "12,470 VOLTS".

The Contractor shall tag the new cables at each splice or termination with 1-1/2 inch diameter brass tags (die-stamped).

2.19.5 Metallic Cable Support Devices

Metallic cable support devices (clamps, straps, hangers or other approved supporting devices) used in the installation of the 15 kV power cables shall be heavy duty, minimum of 1-1/2 inches wide, and with rounded edges where the device comes in contact with the cable jacket. The device shall be PVC coated with a minimum 30 mils coverage where the device comes in contact with the cable jacket or provided with an approved padding between the device and the cable jacket to prevent damage to the cable jacket. Any ends of devices that protrude into personnel access areas shall be padded with foam and yellow and black warning tape.

2.19.6 Cable Fireproofing

The Contractor shall apply fire proofing tape to all exposed single conductor cables including those which are exposed as a result of removal of 3/C cable interlocked armor. The fireproofing tape shall be helically applied with a minimum 20 percent overlap and secured in place using a glass cloth backed tape. The fireproofing tape must be approved by the Contracting Officer. The binding tape shall be a glass cloth electrical tape.

The fire proofing tape shall be applied over the three cables of each feeder as one bundle where feasible. Where the universal splices are staggered this method is not feasible, therefore the single conductor cables must be wrapped individually.

2.20 METERING EQUIPMENT

Metering equipment including voltmeter switch, voltmeter, ammeter switch, demand watt-hour meter with integral pulse relays, current and potential transformers, ammeter, test blocks and mounting hardware shall be furnished complete in accordance with this specification, as indicated on the drawings, and in accordance with applicable National Electrical Manufacturers Association Standards.

Metering equipment shall be for use on a 60 hertz, three phase, four wire, wye connected, 480/277 volt circuit and shall be compatible with the standard UCS (Utility Control System) on site. Information on the UCS System and additional requirements shall be obtained from the Contracting Officer.

2.21 UNDERGROUND WARNING TAPES

Underground warning tape shall be a three layer tape 6 inches wide. The top layer of the tape shall be a polyester with a printed surface. This top layer shall feature subsurface graphics to seal the legend from acids, alkalis and other soil substances. The inner layer of the tape shall have an aluminum foil core. The bottom layer of the tape shall be a polyester underlamine. The tape shall have a minimum thickness of 0.035 inches.

The tape shall be capable of being detected by an above ground metal detector. The tape shall meet OSHA regulation 1926.956(c) (1) covering location of underground utility lines. The wording on the tape shall read either: "CAUTION ELECTRICAL LINE BURIED BELOW" OR "CAUTION BURIED ELECTRICAL LINE". A 24 inch long sample of the tape shall be submitted to the Contracting Officer for approval.

2.22 VIBRATION DAMPING PAD

Vibration damping pad shall be made from a neoprene material. Pad shall have square cells on both sides of the pad. Pad shall have a minimum capacity of 100 pounds per square inch, and a minimum thickness of 0.375 inch. Pad shall be resistant to oil, dirt and water and not require adhesive to eliminate creepage.

The Contractor shall submit SD-1 Data for the pad to the Contracting Officer for approval. In addition, the Contractor shall submit two 12 inch by 12 inch by 0.375 inch sized pads proposed to be installed to the Contracting Officer for approval.

2.23 BUS BAR SILVER PLATING

The Contractor shall provide to the Contracting Officer for approval a certificate of compliance for each panelboard, distribution panel, and switchboard, that is required to have the bus bars silver plated. Each certificate shall indicate the panelboard, distribution panel, and switchgear assembly name, and the amount of silver plating applied to the buses in the respective panels and assemblies.

PART 3 EXECUTION

3.1 GENERAL

Materials and equipment shall be installed in accordance with the requirements indicated, the approved recommendations of the manufacturers, and NFPA 70. The Manufacturer's installations instructions, showing the manufacturer's recommended method and sequence of installation, shall be submitted in accordance with paragraph entitled, "General Requirements" of this section. The installation shall be accomplished by workers skilled in this type of work and shall be done in accordance with the best practice of the trades.

All wiring for the connection of motors and control equipment as indicated on the electrical drawings shall be furnished and installed under this Section of the Specifications.

3.2 WARNING SIGNS

Electrical equipment operating at voltages higher than 600 volts shall have conspicuously located warning signs. The signs shall read: DANGER--HIGH VOLTAGE. Signs shall be readable at a distance of 10 feet and shall be white on red with 1/2 inch minimum letter size.

Electrical equipment operating with an external power supply that remains energized even though the device is disconnected from its normal power source shall have a warning sign that reads: DANGER - EXTERNAL POWER SUPPLY. Signs shall be white on red with 3/16 inch minimum letter size.

3.3 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be the size and number recommended by the equipment manufacturer and shall be located by means of templates.

3.4 PAINTING

Raceways, supports, fittings, cabinets, pull boxes, and racks adjacent to finished surfaces shall be thoroughly cleaned and painted to match color of finish, except as otherwise specified. Work shall be left in a neat and clean condition at final completion of the building.

The enclosure for the following listed items shall be cleaned, primed, and factory painted inside and outside in accordance with MS MIL-T-704. Refer to Section 09920 ARCHITECTURAL PAINTINGS for requirement for outdoors or in harsh environments.

<u>ITEM</u>	<u>FINISH COLOR</u>
Circuit breakers enclosures, switchgear, safety switches, and panelboards	No. 61 gray (No. 16473 per FED-STD 595)
Motors	Manufacturer's standard
Transformers	ANSI No. 61 gray (No. 16473 per FED-STD 595)

3.5 CONDUITS AND FITTINGS

Conduit and fittings shall be installed in accordance with NFPA 70 and as specified herein.

Conduit and raceways shall not be less than 3/4 inch trade size except switch legs run exposed.

Electric metallic tubing (EMT) may be installed indoors in dry locations not subject to mechanical injury. EMT connectors shall be of the compression ring gland type only.

Aluminum conduit and aluminum fittings shall not be used for direct burial, for conduit cast in concrete, or in wet locations. Subject to these limitations, aluminum or other nonmagnetic conduit and fittings shall be used in lieu of steel for wiring-carrying frequencies greater than 180 cycles per second.

Conduit in all locations subject to mechanical injury shall be rigid steel.

Rigid conduit specified for direct burial shall be coated with asphalt or have a factory applied protective coating of 20 mil polyvinyl-chloride coating or prewrapped with half lapped 20 mil adhesive polyvinyl-chloride tape. Fittings and couplings shall be wrapped with 40 mil thickness polyvinyl tape.

When indicated, rigid PVC may be used in concrete encased duct banks except that rigid steel conduit shall be used for stub-ups.

Conduits shall be fastened to all sheet metal boxes, gutters and cabinets with two locknuts and a bushing.

3.6 CONDUIT SYSTEM

Underground Conduit Layout shall be submitted in accordance with the following.

The Contractor shall furnish and install underground conduit systems as specified. It is the Contractor's responsibility for the correct stub-up locations per the drawings and the necessary routing of these conduits such that they are compatible with the foundations and will not damage the cables during the pulling process. Stub-up locations will be determined by the equipment purchased. The Contractor shall submit the proposed layout to the Contracting Officer for approval and shall make note of any major discrepancies or changes. Layout must be approved prior to any trenching for conduits.

The Contractor shall provide and install above grade conduit systems as specified, including all necessary supports, hangers, and other hardware. Systems shall be installed such that there is no interference with normal operations. If there are any major discrepancies, changes, or questionable routing, the Contractor shall notify the Contracting Officer for resolution and/or approval.

Routing of conduits, both overhead and underground, as shown on plan drawings are approximate; and unless located by dimensions may be modified to avoid obstructions. The adjustments shall be held to a minimum to avoid excessive cable pulling tensions or interference with other work. Contracting Officer shall be notified if the routing, direction or elevation of conduit is altered.

Exposed conduit shall be neatly and evenly spaced and shall run parallel to ceiling, floors, walls or other permanent structures.

The Contractor will be held responsible for the placing of all conduits and conduit sleeves passing through walls, partitions, beams, floors, tunnel, roof, etc. If conduit and/or conduit sleeves are not properly installed and cutting and patching becomes necessary, it shall be done entirely at the expense of the Contractor.

Principal openings in masonry floors, walls, and roofs shall be provided as shown on the drawings. Where additional holes or openings become necessary in new or existing masonry structures, Contractor shall inform Contracting Officer of the need. Upon receipt of permission, Contractor shall cut holes or openings of approved sizes. Upon completion of the installations for which holes or openings are cut, the surrounding areas shall be grouted or patched and returned to its original condition and finish by the Contractor.

Before making up conduit runs, the interiors of all conduit, conduit bends, and fittings shall be inspected and cleaned of all dirt, cuttings and other foreign material.

3.6.1 Trenching and Backfill

All trenching by the Contractor shall be coordinated through Contracting Officer to prevent conflicts with other construction and for location of existing or new facilities.

Depth of all trenches shall be sufficient to provide the indicated cover requirements.

The bottom of the trench shall be relatively smooth, undisturbed earth, well tamped earth, or sand.

All trench excavations by the contractor shall be backfilled by him in accordance with this specification.

All fill must be placed in layers not exceeding 8 inches in depth and hand tamped or machine compacted to at least 90 percent of its maximum dry density as computed by the ASTM D 1557 method of performing a compaction test. Machine compaction shall not be used within 6 inches of the cable or duct.

Puddling or water flooding for settling backfill will not be permitted. The addition of water shall be limited to achieving optimum moisture content for tamping procedures.

Where Contractor trenches across any finished surface (paved or gravel), he shall be responsible for restoring the surface to its original condition.

Where trenching through a filled area or unstable ground, the earth shall be excavated to at least 12 inches below the bottom of the trench, tamped as firm as possible, and filled with well tamped select backfill or sand.

3.6.2 Underground Conduit Systems

Unless otherwise specified on the contract drawings, underground conduits shall be rigid hot-dipped galvanized steel (RGS). Fittings and couplings shall be size and type as specified on drawings. The minimum size conduit shall be 3/4 inch. No conduit shall be reduced in size underground.

Underground conduits and duct banks for the power distribution system shall be encased in a concrete envelope providing a minimum encasement of 3 inches on all sides. A minimum spacing of 3 inches shall be maintained between conduits, and this space shall be entirely filled with concrete. The top of this envelope shall be the minimum specified below grade and shall be colored red except within the confines of equipment foundations. Reinforcing rods shall be used in duct runs as shown on the drawings.

Concrete for the envelope shall be a 2000 psi minimum with 1/2-inch maximum size aggregate.

The bottom and sides of the envelope shall be hand sprinkled with a red oxide the entire length. Coloring shall be "Red Oxide Color", C.K. Williams Co., #RD-3097 or approved equal. After the concrete is poured, the top of the concrete shall also be hand sprinkled with the same coloring.

Unless otherwise indicated on drawings, all underground conduits shall be stubbed up 2 inches above finished grade or paving and shall be threaded. Stainless steel metal tags and fasteners shall be attached to all conduits for identification in accordance with the conduit and wire designations at both points of transition from grade.

All conduit stub-ups shall be RGS and plugged with a standard weight RGS conduit coupling and plug during construction and after installation until used to prevent the entrance of foreign materials and to protect the exposed conduit threads.

All underground joints shall be made up tight and the threads coated with an approved lubricant to provide water-tight joints.

Where embedded conduits turn up out of slab or fill, a suitable construction template shall be used to firmly position the conduits per the exact equipment openings.

The conduit system encased in concrete shall be firmly fixed in place by being wired to duct reinforcing steel or by other approved means to avoid being disturbed during placement of concrete. Conduit reinforcing steel shall not be permanently wired or connected to structural reinforcing steel.

Field bent elbows shall maintain a uniform circular cross section throughout the bend with a minimum of radius at the inner edge of the curve as follows:

<u>Size of Conduit</u>	<u>Radius of Bend</u>
3/4 inch	8 inch
1 inch	10 inch
1-1/2 inch	12 inch
2 inch	14 inch
2-1/2 inch	18 inch
3 inch	24 inch
3-1/2 inch	24 inch
4 inch	30 inch
5 inch	36 inch
6 inch	36 inch

All changes of direction or elevation of underground conduit shall be long radius sweeps where possible.

Conduit runs shall not contain more than a total of 360 degrees of bends between pulling points.

Conduits shall be neatly run and evenly spaced, with conduits parallel when in banks. Conduits embedded in foundation or structural concrete shall be run as directly as possible along the generally indicated route between end points, with a minimum length and with a minimum of crossing, bending, and cutting, but without creating interferences with other installations, utility trenches, or pockets.

Before encasement, each conduit shall be thoroughly cleaned inside by pulling a wire brush and then a swab through each duct. All ducts which will not allow this brush and swab to be pulled through shall be replaced with new conduit, and all conduits after cleaning shall be capped at exposed ends in order to keep same clean.

3.6.3 Aboveground Construction

Aboveground conduits shall be as specified on drawings.

All conduit runs shall avoid obstructions and unnecessary bends and shall maintain suitable spacing from hot surfaces to prevent damage to the wire insulation. All overhead conduit runs shall clear steam lines, hot vapor lines, or any other hot objects over 250 degrees F, by 12 inches minimum. Expansion fittings shall be installed to allow movements as required.

Conduit and equipment shall be arranged to prevent the accumulation of moisture in apparatus housing. Drains shall be provided at the low point of long vertical or horizontal runs of conduit.

Field conduit bends shall maintain a uniform circular cross section throughout the bend with a minimum radius at the inner edge of the curve as follows:

<u>Size of Conduit</u>	<u>Radius of Bend</u>
3/4 inch	8 inch
1 inch	10 inch
1-1/2 inch	12 inch
2 inch	14 inch
2-1/2 inch	18 inch
3 inch	24 inch
3-1/2 inch	24 inch
4 inch	30 inch

Conduit bends shall be made by approved bender providing a smooth bend without crushing, cracking, or crimping the conduit or its coating. Heating of conduits to make bends is not permitted. Conduit which has been flattened or wrinkled during bending shall not be used.

Before making up conduit runs, the conduit, conduit bends, and fittings shall be inspected and cleaned of all dirt, cuttings, thread cutting oil, and other foreign material.

There shall be no more than three 90 degree bends, or equivalent, in a run between pull fittings.

All rigid steel conduit threads shall be coated with an approved metal oxide paint or thread lubricant for weatherproof joint and electrical conductivity. Joints shall provide structural rigidity and low electrical resistance across the joints. Conduit runs into boxes without threaded hubs shall have a locknut outside and a locknut and a grounding-type bushing inside unless shown otherwise on the drawings. All open conduit ends shall have grounding type bushings unless other terminations are shown.

Expansion joints, as required, shall be provided on horizontal runs (of 100 feet or more) of conduit.

All unused openings in fittings or equipment shall be plugged with metallic plugs.

Drain fittings shall be provided throughout the conduit system at the points where condensation is likely to be trapped.

3.6.4 Supporting Devices and Hangers

All conduits shall be securely fastened within 3 feet of each outlet box, junction, cabinet, fitting, or end of conduit, or as shown on the drawings.

Contractor shall use center-loading type beam clamps to mount or support electrical equipment. When it is not possible to use center-loading clamps, eccentric-loading beam clamps may be used for conduit sizes 2 inches and less. For conduits sizes 2 inches through 6 inches, provide two counterbalancing clamps per point of pipe support. C-clamps shall not be used.

Conduits and cable trays shall not be supported from piping. No welding to piping will be allowed.

Supports shall be hot-dipped galvanized steel or as indicated on the drawings.

3.7 WIREWAY AND AUXILIARY GUTTER

Straight sections and fittings shall be bolted together to provide a rigid mechanical connection and electrical continuity. Dead ends of wireways and auxiliary gutters shall be closed. Unused conduit openings shall be plugged. Mounting detail shall be as indicated.

Wireways for overhead distribution and control circuits shall be supported at maximum .6 foot intervals.

Auxiliary gutters used to supplement wiring spaces for equipment not contained in a single enclosure shall not contain switches, overcurrent devices, appliances, or apparatus and shall not be more than 30 feet long.

3.8 WIRING

Raceways and wiring shall be installed as indicated, and circuits shall not be combined.

The following raceways and wiring shall be run separate and shall not be combined:

- Fire Alarm Systems
- Utility Control Systems
- Video Systems
- Security Systems
- General Power Systems
- General Lighting Systems
- Water Detection Systems
- Telephone Systems
- Computer Systems

Raceways shall be completely installed, with interiors protected from the weather, before proceeding with the installation of wires and cables. Conductors of special-service systems and emergency light and power systems shall not occupy the same enclosure with light and power conductors or the same enclosure with each other. Conductors shall be continuous with splices and connections made in outlet, junction, or pull boxes only.

Phase conductors and the neutral conductor of each branch or feeder circuit shall be contained in a single enclosure or paralleled in separate enclosures to avoid overheating the raceway by electro and close-up magnetic induction. Conductors and conduit in parallel shall be the same length and size, shall have conductors of the same type of insulation, shall be terminated at both ends in a manner to ensure equal division of the total current between conductors, and shall have a separate neutral and ground conductor in each conduit.

Conductors for motor circuits and control circuits shall be stranded only. Conductors for lighting, branch circuit wiring and control circuits shall be 600 volt, standard copper wire listed by Underwriters' Laboratories as Type THW, THHN, XHHW, or THWN. Wire shall be delivered to the job in original unbroken packages or reels bearing the Underwriters' label. Copper conductors smaller than No. 8 shall be solid or stranded; No. 8 and larger shall be stranded. Wire sizes are American Wire Gauge (AWG).

Minimum wire sizes shall be No. 12 except No. 14 for final connections to small motors and for control, and No. 16 AWG for class 2 low energy conductors. Power conductors shall be stranded copper conductors.

CONDUCTOR SIZE NO.

12, 10, 8

USE

Solid	Receptacles rated 30 amperes and less
Solid	Toggle switches rated 30 amperes or less
Solid	Light fixtures rated 1000 watts or less
Solid	Terminal blocks rated 30 amperes or less
Solid	Circuit breakers rated 30 amperes or less
Solid or stranded	Internal wiring within a control cabinet

CONDUCTOR SIZE NO.

6 AND LARGER

USE

Stranded	Everywhere
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All feeder and branch circuit conductors shall be color coded as follows:

<u>CONDUCTOR</u>	<u>208/120V</u>	<u>480/277V</u>
Phase A	Black	Brown
Phase B	Red	Purple
Phase C	Blue	Yellow
Neutral	White	White
Equipment Grounds	Green	Green

Conductors up to and including No. 2 shall be manufactured with colored insulating materials. Conductors larger than No. 2 shall have ends identified with colored plastic tape in all outlet, pull, or junction boxes. All control circuit conductors shall be identified at each connection point.

Connectors and splices shall conform to FS W-S-610 and shall be made in approved enclosures utilizing solderless pressure connectors and adequate insulation with vinyl-plastic electrical insulating tape. Conductors and materials used in a splice, tap, or connection shall be thoroughly cleaned prior to makeup to ensure good electrical and mechanical connections. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking is not acceptable. Each wire shall be marked with preprinted heat-shrink wire sleeves for easy identification.

3.9 MEDIUM VOLTAGE CABLES

All 15kV conductors shall be color coded as follows:

Phase A - Red
Phase B - White
Phase C - Blue

The existing phase rotation shall be verified by the Contractor and the new feeders installed accordingly. The new transformers phase rotation shall match the existing site phase rotation.

3.10 CABLE INSTALLATION

Cables shall be installed in conduits or with the specified support systems in accordance with the drawings. Any change in routing or method of installation will be permitted only with the approval of the Contracting Officer.

Each section of cable shall be protected with temporary tape and/or coatings to prevent moisture from entering cable ends before termination is completed.

Cable attachments for pulling shall be woven cable grips or similar devices with a swivel connection subject to Contracting Officer's approval. If abnormally difficult pulling occurs, Contractor shall check pull required, manufacturer's maximum pulling tension allowable, and if necessary, suspend pulling until a revised procedure has been approved by the Contracting Officer.

Maximum cable pulling tension shall not exceed values recommended by cable manufacturer.

Cables and wires shall be identified at each end and in pull boxes with identifying numbers called for on drawings.

Cable reels shall be handled with care. Do not drop reels or allow flange to bump cables on adjacent reels. Do not lift reels under turns of cable or bracing. Approved cable reel stands shall be used when removing cable.

Circuit conductors shall be same AWG size from source to load. Neutral wires shall be same size as phase wires except as noted on the drawings.

3.11 CABLE TERMINATIONS AND SPLICES - 15 kV

Terminations in 15 kV cable shall be made by craftsmen experienced in cable terminations and splicing and shall have the following:

- Approved Universal (25 kV) CE type terminations

- Approved stress cone kits

- Each individual conductor shield shall be connected to ground

- Approved termination kits

3.12 CABLE TERMINATIONS AND CONNECTIONS - 600 VOLT AND LESS

It is the intent that the Contractor shall terminate all conductors and in such a manner that the various functions are performed as intended, and he shall be responsible for rearrangement as necessary to satisfy these requirements. If there is any question as to proper connection, the Contractor shall make temporary connections with sufficient length so that conductor can be switched to another terminal without splicing. Splices will not be accepted (except for specified circuits or lighting branch circuits at approved locations), and any conductors cut too short shall be replaced at the Contractor's expense.

Control conductor terminations shall be made in accordance with schematic and/or connection diagrams using conductor numbers as assigned on the diagrams.

Power and control conductors shall be rung out and identified before terminal connections are made. Polarity, phasing, and rotation shall be checked and changes made as required before terminal connections are made.

Terminations shall be made using compression-type lugs, unless otherwise specified. Connections at transformers and other similar connections to insulated leads or buses shall be covered and taped in a manner appropriate to the class of insulation originally on the conductor.

The Contractor shall submit a sample compression connection for each type of termination for approval by Contracting Officer. The following information is required with each sample: Cable data (type, size, insulation, jacket, physical data, etc.), type of hydraulic compression device, type of compression dye, and type of compression connector. Mechanical connectors are not acceptable.

All stranded wire connections, No. 10 AWG and smaller, to binding screw type equipment terminals shall be vinyl insulated, ring-type lugs, T&B Sta-Kon or equal. Compression fitting shall not be permitted on solid wire.

All 600 volt rated wire connections, No. 8 AWG and larger, to stud-type or flat-bar type equipment terminals shall be terminated with a compression type lug. Contractor shall furnish one sample crimp of each wire size to be installed. Contractor shall crimp each lug per manufacturer's printed instructions with the manufacturer's recommended die tool.

All splices and taps in 600-volt rated wire, for lighting systems, No. 10 and smaller shall be T&B Sta-Kon, or equal, pressure connector with insulation cap.

All splices and taps in 600 volt rated wire for lighting systems, No. 8 and larger, shall be Burndy-Servit KS connector or equal. Servit connectors shall be insulated with 3 half-lapped layers of Scotch Brand, or equal, electrical tape, or approved molded insulation.

3.13 CONDUIT AND WIRE IDENTIFICATION TAGGING

Each conduit containing a feeder cable, each multiconductor cable, and each bundle of single conductor wires shall be tagged with identification tags or identification ties. Each wire shall be marked with preprinted heat-shrink wire sleeves.

Stainless steel tags shall be installed at each end of conduit or cable, on each side of walls or floors, where cable enters or leaves equipment lineup, and where a conduit or cable passes through a junction box, wiring trench or pullbox.

Each single conductor wire or individual conductors of multi-conductor cables shall be identified at each end or where individual conductors separate from their main bundle.

The 15kVA feeders, from the substation to the switches, shall be numbered by the Bus number and the Breaker number. An example of this is "Feeder 5-11".

All other cables will be numbered to indicate the source device number and the termination device number. The source device of the electrical wire may be a Motor Control Center, a Lighting Panel, or a Receptacle Panel. An

example of the termination device may be a Motor Control Center, a Lighting Panel, a Receptacle Panel, a pump, or an Air Handling Unit. Should a wire be fed through a pull box or a junction box, the wire should be labeled at that device. Refer to Figure 1 and Figure 2 at the end of this section for examples of a cable numbering system.

3.14 WIRING DEVICES

3.14.1 Wall Switches and Receptacles

Wall switches and receptacles shall be so installed that when device plates are applied, the plates will be aligned vertically to within 1/16 inch.

The ground terminal of each flush-mounted receptacle shall be bonded to the outlet box with an approved green bonding jumper.

The grounding contacts for the receptacle shall be pointed to the floor.

3.14.2 Device Plates

Device plates for switches that are not within sight of the loads controlled shall be suitably identified with a nameplate with a description of the loads.

Device plates and receptacle cover plates for all receptacles shall be labeled, showing the circuit number, voltage, frequency, phasing, and amperage available at the receptacle; for example: "RP1-12, 208 volts, 60 hertz, 3 phase, 30 amperes". An engraved metal identification label shall be applied. The labels shall be W.H. Brady Co., Part Number CL-317-969-BK size 317 CUAU 32475 or approved equal.

3.15 BOXES AND FITTINGS

Pullboxes shall be furnished and installed on conduit runs longer than 100 feet or with more than three right-angle bends.

Outlet boxes shall be equipped with plaster rings, extension rings, and fixture studs where required. All unused openings in boxes shall be closed with factory made knockout seals. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number and panel designation.

Boxes and enclosures shall be securely mounted to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

3.16 CONTROL CIRCUIT IDENTIFICATION

Control circuit terminals of equipment shall be properly identified by number-coded plastic heat-shrink printed markers, or permanently attached stamped metal-foil markers.

This paragraph shall apply to equipment purchased under all sections of these specifications.

3.17 MOTORS

Shaft alignments will be checked with a dial type indicator. Alignment tolerances shall be with the limits specified by the motor manufacturer and

the coupling manufacturer. All anchor bolts and shim plates shall be torqued to limits for the size anchor bolts used. Motors shall be checked for proper rotation before final connection to load. A record of the no-load current, voltage and speed shall be made. Motor vibration and sound levels shall be taken at no load and full load conditions and these levels shall be within the limits as specified in NEMA MG 1.

3.18 MOTOR DISCONNECT

Each motor shall be provided with a disconnecting means under this section of the specifications, when required by NFPA 70. For single-phase motors, a single- or double-pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Enclosed safety switches shall be horsepower rated. Switches shall disconnect all ungrounded conductors.

Switches shall be securely fastened to the supporting structure or wall utilizing a minimum of four 1/4-inch bolts. Sheetmetal screws and small machine screws shall not be used for mounting. Switches shall not be mounted in an inaccessible location or where the passageway to the switch may become obstructed. The mounting height shall be approximately five feet above floor level, when possible.

3.19 GROUNDING

The Contractor shall furnish and install both the underground and above grade grounding systems and shall connect to the existing system as indicated. All underground connections shall be exothermic thermowelds and above grade connections shall be as shown on the drawings. Ground rods and ground wells shall be installed as shown and at any other locations as necessary such that each grounding circuit shall have a resistance of not greater than one (1.0) ohm when interconnected with other circuits. All underground connections shall require visual inspection and approval by Contracting Officer before backfilling.

The grounding circuit shall consist of driven-ground rods, a loop connection to the ground rods, and a grid interconnecting to the loop. Equipment and building ground shall be connected to this circuit. Grounding shall be in accordance with NEC and IEEE Standard 142, "Grounding of Industrial and Commercial Power System".

Grounding circuits of lightning arresters, and rods must run in the most direct manner to the nearest selected grounding electrode. It must be connected to ground point on (frame) machine or equipment to be protected by shortest possible lead.

Grounding cable shall be soft drawn bare-stranded (SDBS) copper as specified on the drawings, details, etc.

Cables shall be run at a minimum depth of 18 inches below finished grade. The routing of ground wires shown on plan drawings is approximate, and unless located by dimensions, may be adjusted to avoid obstructions. Underground taps or splices shall be made using the exothermic thermoweld or Burndy Hyground method, and in an approved manner. All ground wires emerging from below grade for aboveground connection shall be of the required length, either straight or looped, from where it leaves the ground as shown on the applicable drawings. The free length of wire shall be coiled and tied for protection against damage.

Ground wires that penetrate a concrete slab shall pass through a sleeve made of Schedule 40 PVC conduit with a collar on the top side. The nipple and collar shall be long enough to penetrate the full thickness of the concrete slab with the collar being flush with the finished slab surface.

All above grade grounding conductors shall be protected and routed to avoid any physical damage.

All bolted grounding connections shall be cleaned of paint or unacceptable foreign substances to guarantee metal-to-metal contact. Grounding connections to aluminum surfaces shall be made with tinned-bolted connectors.

The equipment grounding conductor shall in no case be a system neutral or a current-carrying conductor.

Ground rods shall be copperweld-ground rods, 3/4-inch diameter, 10-feet long, steel core, copper exterior with conical wedged point. Where deep penetration in the earth is necessary to reach permanent moisture level, the rods may be jointed sections to obtain the necessary length.

Main ground loop shall be No. 4/0 SDBS copper. Tap conductors shall be No. 2/0 SDBS copper.

The noncurrent carrying parts of all electrical equipment shall be grounded to the equipment ground serving this equipment. All mechanical connections on equipment and structures shall be coated with ScotchKote or equal, then wrapped with plastic tape and cover the plastic tape with ScotchKote or equal. Where tape cannot be used, coat joint with ScotchKote or equal.

3.20 LIGHTING FIXTURES

A fixture shall be installed at each outlet indicated, and lamps of the proper type and wattage shall be installed in each fixture.

New lamps shall be installed immediately prior to completion of the project.

Fixture shall be installed parallel and perpendicular to major axes of structures and shall be plumb and aligned to a tolerance of 1/2 inch in 10 feet.

Supports for recessed fixtures shall have a minimum capacity of 150 pounds, and all parts of the support shall be arranged to prevent their vibrating free.

Surface-mounted fixtures shall be attached securely to structural members or to metal supports which span structural members. Fixtures shall be fastened near each end and, if over 4 feet long, shall also be fastened at the center. If surface-mounted fixtures are not of a type approved by the UL for direct mounting on combustible ceilings, suitable spacers shall be installed.

Fixtures located in equipment rooms shall be so installed that they clear all obstructions such as duct, piping, bracing, and supports.

3.21 FLEXIBLE CONDUIT

Flexible conduit of short length shall be provided for all motors,

transformers, and other equipment subject to vibration or movement. Liquid-tight flexible conduit shall be used in wet locations.

3.22 INSTALLATION OF UNDERGROUND WARNING TAPE

Underground warning tape shall be buried directly above all underground conduit(s) that are either individually direct buried or in a duct bank. The tape shall run the full length of the conduit(s) or duct bank. The warning tape shall be installed 6 inches below grade. A 4 inch long section of the tape shall remain exposed at the beginning and the end of the conduit(s) or duct bank. One underground warning tape shall be used for a series of conduits or a duct bank that is 12 inches or less in overall width. Two or more underground warning tapes shall be installed in a series of underground conduits or a duct bank that exceeds 12 inches in width. The tape shall be arranged above the conduits or duct bank so that no more than 6 inches of the conduits or duct bank is not covered by the tape.

3.23 VIBRATION DAMPING PAD

Vibration damping pad shall be installed under all vibrating equipment. This includes but is not limited to all transformers (both dry and liquid filled transformers), switchgear, switchboards, panelboards, and high voltage switches (600 volts and above) both indoor and outdoor.

3.24 EQUIPMENT PADS

Equipment pads shall be provided where indicated on the drawings and shall be the dimensions shown, or, if not shown, shall conform to the shape of each piece of equipment served with a minimum 4 inch margin around the equipment and supports.

3.25 CUTTING AND PATCHING

The Contractor shall install his work in such a manner, and at such time, as will require a minimum of cutting and patching of the building structure.

All holes in or through existing masonry walls and floors shall be drilled and smoothed by sanding in exposed locations. The use of a jack hammer will be permitted only where specifically approved.

3.26 DAMAGE TO WORK

All required repairs and replacement of damaged work shall be done as directed by, and subject to the approval of, the Contracting Officer, and at no additional cost.

3.27 CLEANING

Exposed surfaces of wireways, conduit systems and equipment which have become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces, are prepared for final finish, painting, or are enclosed within the building structure.

Before final acceptance, all electrical equipment, including fixtures and glass, shall be clean and free from dirt, grease, and finger marks.

3.28 FIELD TESTING

Test Reports, shall be submitted for Conductor Continuity, Conductor

Insulation, Phase Rotation, Circuit Breakers, and Ground Rods in accordance with the following.

After completion of the installation and splicing, joints, and terminations, and prior to energizing the conductors, wire and cable shall be given continuity and insulation tests as herein specified.

Necessary test equipment, labor, and personnel shall be provided by the Contractor to perform the tests, as herein specified. Continuity tests shall be conducted using a dc device with bell or buzzer.

Wire and cable in each voltage classification shall be completely isolated from all extraneous electrical connections at cable terminations and joints. Substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices shall be used to isolate the circuits under test.

Insulation tests on 480-volt circuits shall be conducted using a 500- or 1000-volt insulation-resistance test set. Readings shall be taken every minute until three equal and consecutive readings are obtained. The resistance between phase conductors and ground shall be not less than 50 megohms.

Insulation tests on circuits rated 240 volts or less, with conductor sizes 2 AWG and larger, shall be conducted using a 500- or 1000-volts insulation-resistance test set. Readings shall be taken after one minute or until the reading is constant for 15 seconds. The resistance between phase conductors and ground shall be not less than 25 megohms.

Phase-rotation tests shall be conducted on all three-phase circuits using a phase-rotation indicating instrument. The phase rotation of electrical connections to all connected equipment shall be clockwise.

Final acceptance will depend upon the satisfactory performance of wire and cable under test. No conductor shall be energized until the installation is approved.

All molded case circuit breakers with a frame size of 225 amperes or larger and all low-voltage power circuit breakers shall be tested by the Contractor to demonstrate proper operation of installed features. The following applicable features shall be tested on each circuit breaker: 1) Current setting; 2) Long-time delay; 3) Short-time pickup; 4) Short-time delay; 5) Adjustable instantaneous pick-up; 6) Ground fault pick-up; 7) Ground fault delay; 10) Shunt trip coil; 11) Under voltage release coil; 12) Auxiliary switch; 13) Bell alarm switch; 14) Neutral current sensors. Each circuit breaker shall be tested by a certified circuit breaker testing laboratory. The Contractor shall furnish all required test equipment. Prior to testing the circuit breakers, the Contractor shall furnish the name of the testing laboratory, and the time trip current curves for each circuit breaker to be tested to the Contracting Officer for approval. The Contractor shall perform a primary injection test (multi-amp) on each circuit breaker that is required to be tested, including circuit breakers having a solid state trip element. The Contractor shall submit to the Contracting Officer for approval, a sample copy of the proposed test report for the circuit breakers. The Contractor shall furnish a written certified test report for each circuit breaker tested. The test report shall be approved by the Contracting Officer.

Test thermal-overload protection devices in controllers for three-fourths

horsepower and larger motors to show proper coordination with rated motor current.

Electrical protective devices shall be tested to demonstrate proper characteristics.

Ground rod tests shall indicate the resistance of each rod, location and soil condition. The Contractor shall submit to the Contracting Officer a drawing with all of this information on it.

Upon completion of the electrical work, and at such time as the Contracting Officer may direct, an operating test of the electrical systems shall be conducted. All electrical equipment shall be demonstrated to operate in accordance with the requirements specified and indicated.

All tests required throughout the specifications shall be conducted in the presence of the Contracting Officer with all test results accurately recorded on forms furnished by the Government. The Contracting Officer shall sign off the test records after each test and shall state whether equipment is acceptable, rejected, or requires retesting. The Contractor shall submit detailed test procedures (with equipment) for review and approval by the Contracting Officer.

3.29 OPERATION AND MAINTENANCE MANUALS

The O&M manual shall be a complete manual containing all the required information as identified below and shall be grouped by equipment consisting of manufacturer's standard brochures, schematics, printed instructions, and procedures.

Maintenance Instructions - Provide procedures for preventive maintenance of all equipment. The procedure shall identify the time-based frequency to inspect; condition monitor; perform predictive testing; adjust, lubricate, clean, and change filters to ensure an effective and reliable maintenance program of each component, device, system, and of the integrated system itself.

Operating Instructions - The instructions shall include startup, shutdown, safety, normal and emergency operation procedures; testing and startup instructions; and pre-startup maintenance and operating checkouts. The procedures shall include electrical and mechanical schematics, control diagrams, ladder logic diagrams for any PLC's, and control sequence of operations that describe the entire range of equipment operations with all the parameters for alarm, shutdown, and control set points. The operating instructions shall address the physical and functional relationship of equipment within a system and include integrated operational instructions and electrical interconnect drawings. These drawing shall be in one-line drawing form showing the layout of all controls and the interconnection between systems.

Parts List - A list of parts, tools, and components for the system by manufacturer's name, part number, nomenclature, and quantity.

Preventive Maintenance and Inspection - Procedures and instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication, and cleaning necessary to minimize corrective maintenance and repair.

Repair Requirements - Provide procedures to checkout, troubleshoot, repair,

and replace components of the equipment or systems. The procedures shall include manufacturer's integrated electrical schematics and diagrams, and diagnostic techniques necessary to totally troubleshoot the mechanical, electrical, electronic, and pneumatic components or systems.

Safety Considerations - Information relating to load limits, speeds of operation, environmental criteria, temperature and pressure limitations, and personnel hazards and equipment safety precautions.

Spare Parts Data - Data shall include a complete list of recommended spares by part number and nomenclature and spare stocking levels, with current unit prices and source of supply to ensure efficient operation for a period of 120 days at the particular installation.

Special Tools - A list of special tools and test equipment required for maintenance, repair, and testing of the equipment.

-- End of Section --



SECTION 16275

DISTRIBUTION TRANSFORMERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C57.12.26 (1992) Transformers - Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High Voltage, (34 500 Grd Y/19 920 and Below; 2500 kVA and Smaller)

ASTM INTERNATIONAL (ASTM)

ASTM D 877 (2000) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes

ASTM D 924 (1999) Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.00 (2000) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

IEEE C57.12.80 (1978; R 1992) Standard Terminology for Power and Distribution Transformers

IEEE C57.12.90 (1999) Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers

IEEE Std 62 ((1995) Guide for Diagnostic Field Testing of Electric Power Apparatus-Part 1: Oil Filled Power Transformers, Regulators, and Reactors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ST 20 (1992; R 1997) Dry Type Transformers for General Applications

U.S. DEPARTMENT OF ENERGY (DOE)

DOE CI-2

(2000) How to Buy an Energy-Efficient
Distribution Transformer

UNDERWRITERS LABORATORIES (UL)

UL 506

(2000) UL Standard for Safety Specialty
Transformers

1.2 GENERAL REQUIREMENTS

Section 16003 GENERAL ELECTRICAL PROVISIONS applies to work specified in this section.

Certification of previous tests on similar units under actual conditions may be submitted for impulse tests, temperature rise tests, sound tests, power-factor tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.

Equipment and performance data shall be submitted for distribution transformers including resistance measurements, impedance, efficiencies and voltage and load losses at rated currents.

Equipment foundation data for distribution transformers shall include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTALS PROCEDURES in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

The following shall be submitted for distribution transformers:

Connection Diagrams
Fabrication Drawings
Installation Drawings

SD-03 Product Data

Equipment and Performance data and Equipment Foundation Data shall be submitted for distribution transformers.

Manufacturer's catalog data shall be submitted for the following items:

Dry-Type Distribution Transformers

Pad-Mounted Liquid-Filled Distribution Transformers

SD-06 Test Reports

Test reports shall be submitted for the following tests on

distribution transformers in accordance with the paragraph entitled, "Field Testing," of this section.

Insulating Liquid Tests
Power Factor Tests
Insulation Resistance Tests
Insulation Power Factor (Doble) Tests

SD-07 Certificates

Certification of previous tests on similar units (type-testing) under actual conditions may be submitted for impulse tests, efficiencies, temperature-rise tests, sound tests, power-factor tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following equipment:

Dry-Type Distribution Transformers

Pad-Mounted Liquid-Filled Distribution Transformers

1.4 FACTORY TESTING

Tests on transformers shall comprise the manufacturer's standard tests including resistance measurements of all windings; ratio tests; polarity and phase-relation tests; no-load loss at rated voltage; impedance; voltage and load loss at rated current; insulation power factor (Doble) tests, insulation oil tests, and dielectric tests. For oil-filled units manufacturer shall certify that the oil contains no PCB's and shall affix a label to that effect on the transformer tank and on each oil drum containing the insulating oil.

1.5 DRAWINGS

Connection diagrams shall be submitted for distribution transformers indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system or portion of system with another, and internal tubing, wiring, and other devices.

Fabrication drawings shall be submitted for distribution transformers consisting of fabrication and assembly details to be performed in the factory.

Installation drawings shall be submitted for distribution transformers in accordance with the paragraph entitled, "Installation," of this section.

PART 2 PRODUCTS

2.1 EQUIPMENT STANDARDS

2.1.1 Dry-Type Distribution Transformers

General-purpose dry-type transformers for connection to low-voltage

distribution circuits of 600 volts or less and the supply of current for lighting and power loads shall be two-winding, 60-hertz, self-contained, self-cooled, Class AA in accordance with NEMA ST 1 and UL 506.

Insulation system limiting temperature shall be in accordance with the following table, with a temperature rise of:

<u>Dry-Type Class</u>	<u>Maximum Rise by Resistance</u>	<u>Reference Temperature</u>
A	55 degrees C	75 degrees C
B	80 degrees C	110 degrees C
F	115 degrees C	135 degrees C
H	150 degrees C	180 degrees C

2.1.2 Pad-Mounted Liquid-Filled Distribution Transformers

Pad-mounted liquid-filled distribution transformers with primary connections to underground high-voltage lines and secondary connections to underground low-voltage distribution feeder circuits shall be two-winding, single- or three-phase, as indicated, 60-hertz, oil-immersed, 65-degree C rise, self-cooled, Class OA, outdoor type, conforming to ANSI C57.12.25, ANSI C57.12.26, IEEE C57.12.80, and IEEE C57.12.90. Primary windings of three-phase pad-mounted transformers shall be wye connected

2.1.3 Efficiencies

Distribution transformers shall have efficiencies in accordance with the recommended levels specified in DOE CI-2.

2.2 FACTORY FINISH

Transformers shall be provided with the manufacturer's standard paint finish when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09920 ARCHITECTURAL PAINTINGS

PART 3 EXECUTION

3.1 INSTALLATION

Dry type transformers shall be installed on resilient vibration-isolating mountings and connected with flexible metallic conduit to prevent transmission and amplification of sound.

Pad-mounted distribution transformers shall be installed on poured-in-place concrete pads and shall be grounded to a ground grid.

Provisions shall be made for forced cooling and related requirements. Voltage and kilovolt-ampere (kVA) ratings shall be as noted.

Each pad-mounted distribution transformer shall have its kVA rating conspicuously displayed in 3-inch high yellow letters on its tank or enclosure in addition to the complete manufacturer's standard identification plate.

3.2 FIELD TESTING

Transformers shall be tested in accordance with IEEE Std 62.

3.2.1 Insulating Liquid Tests

3.2.1.1 Dielectric Tests

Liquid filled transformers shall have the insulating liquid dielectrically tested after installation and before being energized. Insulating liquid shall be tested in accordance with ASTM D 877, and breakdown voltage shall be not less than 33,000 volts.

3.2.1.2 Power Factor Tests

Liquid filled transformers shall have the oil power factored at 20 degrees C, per ASTM D 924 prior to being energized. Results shall not be greater than 0.5 percent at 20 degrees C.

3.2.2 Insulation-Resistance Tests

Transformer windings shall be given an insulation-resistance test using the following test set versus voltage level criteria:

Dry type 480- to 600-volt transformers - 1,000-volt test set

Dry type 240-volt and below transformers - 500-volt test set

Liquid type 15-to 5-kilovolt transformers - 5000-volt test set (primary)

Readings shall be recorded every 15 seconds for the first minute and every minute thereafter for 10 minutes. Resistance between phase conductors and ground shall be no less than the following:

Liquid type 5 to 15 KV - 125 megohms

Dry type 600 volt to 5 KV - 500 megohms

3.2.3 Insulation Power Factor (Doable) Tests

Transformer windings shall be given an insulation power factor test and winding excitation test in accordance with ANSI IEEE C57.12.90. Insulation power factor shall not exceed 0.5 percent for new liquid filled units. New dry type units can have power factors up to 5.0 percent and still be acceptable.

3.2.4 Acceptance

Final acceptance shall depend upon the successful performance of the equipment under test. Transformers shall not be energized until recorded test data have been approved by the Contracting Officer. Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --



SECTION 16329

LOAD BREAK SF6 GAS SWITCHES

PART 1 GENERAL

1.1 REFERENCES

The following publications form a part of these specifications to the extent indicated by their references. The exclusion of a publication from this section will not relieve the Contractor from complying with the publication reference elsewhere.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C37.71 (1984) Three-Phase Manually Operated
Subsurface Load-Interrupting Switches for
Alternating-Current Systems

FEDERAL SPECIFICATIONS (FS)

FS TT-C-490 (Rev C; Am 2) Cleaning Methods for Ferrous
Surfaces and Pretreatments for Organic
Coatings

FS TT-E-489 (Rev J (Canc. Notice 1)) Enamel, Alkyd,
Gloss, Low Voc Content

FS TT-P-645 (Rev B) Primer, Paint, Zinc-Molybdate,
Alkyd Type

FEDERAL STANDARDS (FED-STD)

FED-STD 595 (Rev B, Notice 1) Colors Used in
Government Procurement

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330,
"Submittals":

SD-02 Shop Drawings

Connection Diagrams shall be submitted for the following in
accordance with the paragraph entitled, "Connection Diagrams," of
this section.

Load Break SF6 Gas Switches

SD-02 Shop Drawings

Shop Drawings shall be submitted for the following in accordance
with the paragraph entitled, "Shop Drawings," of this section.

Elementary Diagrams

Fabrication Drawings
Installation Drawings

SD-03 Product Data

Equipment and Performance Data shall be provided for the following in accordance with the paragraph entitled, "Equipment and Performance Data," of this section.

Load Break SF6 Gas Switches

SD-03 Product Data

Manufacturer's Catalog Data shall be submitted for the following in accordance with the paragraph entitled, "Manufacturer's Catalog Data," of this section.

Load Break SF6 Gas Switches

SD-05 Design Data

Equipment Foundation Data shall be submitted for the following in accordance with the paragraph entitled, "Equipment Foundation Data," of this section.

Load Break SF6 Gas Switches

SD-06 Test Reports

Certified Factory Test Reports shall be submitted for the following and shall be in accordance with the paragraph entitled, "Design Type Testing", of this section.

Load Break SF6 Gas Switches

SD-09 Manufacturer's Field Reports

Field Test Reports shall be in accordance with the paragraph entitled, "Field Testing" of this section, and the following submitted:

Insulation Resistance Tests
High Voltage 60 Hertz Withstand Test

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted for the following in accordance with the paragraph entitled, "Manufacturer's Instructions," of this section.

Load Break SF6 Gas Switches

SD-10 Operation and Maintenance Data

Operation and Maintenance Data shall be submitted in accordance with the paragraph entitled, "Operation and Maintenance Data," of this section.

1.3 GENERAL REQUIREMENTS

Sections 16102, "Electrical Work," and 16286, "Overcurrent Protective Devices," apply to work specified in this section.

1.4 DESIGN TYPE TESTING

Certified Factory Test Reports of design type tests conducted in strict accordance with the provisions of ANSI C37.71 shall be submitted for Load Break SF6 Gas Switches. All test data is subject to Government review and approval.

1.5 SHIPPING

Prior to shipment, the completed switch assembly shall be pressurized and submerged in water for 15 minutes to ensure that a hermetic seal is obtained. Switches shall be shipped sealed and filled.

Switch shall not be shipped to site until after certified tests are approved. The switch shall be inspected and approved by a NASA representative before shipment unless waived by Contracting Officer in writing.

1.6 EQUIPMENT AND PERFORMANCE DATA

Equipment and Performance Data information on use life, system functional flows, safety features, and mechanical automated details shall be submitted for Load Break SF6 Gas Switches.

1.7 EQUIPMENT FOUNDATION DATA

Equipment Foundation Data shall include plan dimensions of the foundation and related elevations; equipment weight and operating loads; horizontal and vertical loads; size, location, and projection of anchor bolts; and horizontal and vertical clearances for installation, operation, and maintenance for Load Break SF6 Gas Switches.

1.8 MANUFACTURER'S CATALOG DATA

Manufacturer's Catalog Data (catalog cuts, brochures, circulars, specifications, product data, and other printed information) shall be provided showing in sufficient detail and scope to verify compliance with the requirements of the contract documents shall be submitted for the Load Break SF6 Gas Switches.

1.9 CONNECTION DIAGRAMS

Connection Diagrams in the three line format, indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnecting of one system (or portion of system) with another, and internal wiring, and other devices, shall be submitted for the Load Break SF6 Gas Switches.

1.10 SHOP DRAWINGS

Elementary Diagrams indicating, in straight-line form and without regard for physical relationship, supporting systems and elements of equipment and associated apparatus, shall be submitted for the following. Items shall be clearly labeled to indicate rates and use in the system. Fabrication Drawings consisting of fabrication and assembly details shall be performed.

at the factory and submitted for Load Break SF6 Gas Switches. Installation Drawings indicating overall physical features, dimensions, ratings, service requirements, and equipment weights and shall be submitted for Load Break SF6 Gas Switches in accordance with the paragraph entitled "Installation" of this section.

1.11 MANUFACTURER'S INSTRUCTIONS

Manufacturer's Instructions shall be submitted for Load Break SF6 Gas Switches including special provisions required to install equipment components and system packages. Special notice shall detail impedances, hazards and safety precautions.

1.12 OPERATION AND MAINTENANCE DATA

The Contractor shall provide six 6 up-to-date final asbuilt copies of the Operation and Maintenance Manuals as specified in JSC Submaster Section 01330, "Submittals".

PART 2 PRODUCTS

2.1 SWITCHES

Load break switches shall be SF6 gas insulated, manually operated, load interrupting type load break switches and shall be rated 15,000, volts, 600 amperes, minimum, continuous and load break for operation on a 12.47 kV, 3-phase, 3 wire system. Switch shall have momentary rms asymmetrical rating of 40,000 amperes and close rms symmetrical rating of 25,000 amperes for 10 seconds, 60 hz withstand voltage rating of 35,000 volts and basic impulse insulation level (BIL) of 110 kilovolts. Switches shall be the type indicated and shall be designed to be able to view the internal wiring, indicating each switch position. Switches shall be pad-mounted, as indicated. The front, back, and two sides of the switch mounting frame shall be covered with heavy-gage, painted, sheet metal. All wiring and bussing shall be copper.

The enclosure for the switch and fuses shall be equipped with a full length ground bus capable of carrying the rated fault current for 1 second. Ground bus shall be equipped at each end with Burndy lugs for #2 - #4/0 wire.

Each switch shall have pressure gage, position viewing window and fill plug. The switch link subassembly shall have a bearing support at each end. The operating shaft shall have an "O" ring type operating shaft seal.

Cable terminations at line switches shall be made with only approved 15KV terminators as specified in Section 16125, "Medium Voltage Power Cables." The switches shall be equipped with Universal apparatus bushings to accept Universal splice terminators or with dead-front bushings to accept load break elbows, as specified or indicated.

Cable terminations from the fuse compartment shall be preformed stress-cones.

Outputs shown as spare or future use shall be provided with bushing compartments and a termination body with a positive seal.

Provisions for padlocking each handle in any position shall be provided.

Each switch tank shall be constructed of minimum 1/4-inch steel plate, fully welded.

The operating mechanism shall be suitable for manual operation or for operation by a motor operated system. The operating mechanism shall come equipped with handles for manual operation and shall be operated by a non-teasible, snap-action, quick-make, quick-break stored energy mechanism.

The opening and closing of the main contacts shall be totally independent of the speed or position of the operating handle. The operating handle shall be secured to the shaft in a manner that will ensure tightness and alignment.

The individual switch links shall be notched and pinned to prevent rotation of the links in their supports. Stops shall be provided in the switch tank to limit the movement of the switch link subassembly beyond its two end positions.

2.2 ACCESSORIES

All necessary accessories shall be provided.

All gaskets shall be on piece, without joints.

Switches shall be equipped with ambient temperature compensated gas pressure gage with the appropriate range for the normal SF6 pressures within the enclosures. Switch shall be equipped with auxiliary indicator switches with form "C" (SPDT) contacts; rated for 120 VAC, 1A minimum, showing the position of each switch. Auxiliary indicator switches shall be prewired to a terminal block for future connection by NASA. Switches shall be equipped with low pressure alarm contacts (form "C", SPDT) on the switch tank.

Fuses in a separate compartment shall be provided on the outgoing feeders as indicated and per Section 16286, "Overcurrent Protective Devices". Fuse compartment doors shall be interlocked with switch mechanisms.

2.3 SPACE HEATERS

The ventilated cable termination compartment and the fuse compartment on outdoor switches shall be equipped with externally energized space heaters to provide approximately 4 watts/square foot of outer surface area. The heaters shall be such that the power density does not exceed 4 watt per square inch of heater element surface. Heaters shall be rated at 240 volts for connection at 120 volts. (Caution: Wattage supplied by heaters is one-fourth of heater nameplate rating when 240 volt heaters are operated at 120 volts.) The heaters shall be located at the lowest portion of each space to be heated. Terminals shall be covered. Thermostats shall be used to regulate the temperature. Thermostats shall be industrial type, high limit, to operate on temperature rise, with a range of 50 to 90 degrees F.

All heaters shall be installed and operable at the time of shipment so that the heaters can be operated immediately on arrival at the site, during storage, or before installation. Connection locations shall be marked prominently on drawings and shipping covers with temporary leads for storage operation easily accessible without removal of shipping protection.

2.4 EXTERNAL VOLTAGE SOURCE

All externally powered wiring to the switch shall be grouped together as much as possible and connected to a terminal block which shall be marked with a laminated plastic nameplate having 3/16 inch high white letters on a red background as follows:

(DANGER-EXTERNAL VOLTAGE SOURCE)

Externally powered wiring will include 120V AC unit space heaters and indicator switches.

2.5 COORDINATION

The power fuses shall be coordinated with the circuit breaker settings in the substation and with the transformer rating. The time-current characteristics, minimum melt and total clear times shall be as required.

2.6 MOUNTING FRAMES

Mounting frames of angle-iron construction, hot-dip galvanized after fabrication, shall be furnished for all pad-mounted switches.

2.7 SHOP FINISHING

After fabrication, all exposed ferrous metal surfaces of the pad mount enclosure shall be cleaned and painted.

Cleaning and phosphatizing treatment prior to the application of paint shall conform to FS TT-C-490. Hot-rolled steel sheet and plate shall be sand, shot, or grit-blasted to white metal to obtain a completely clean surface before phosphatizing. Cold-rolled steel sheet and plate shall be cleaned of all dirt, grease, or oil before phosphatizing.

Exterior surfaces, except the bottoms of weatherproof enclosures, and interior surfaces, except machined parts, shall be given a prime coat and two finish coats of paint.

Prime coat paint shall be zinc chromate in an alkyd vehicle conforming to FS TT-P-645.

Finish-coat paint shall be pigmented alkyd gloss enamel conforming to FS TT-E-489. The color of exterior finish shall be No. 16473 (ANSI No. 61 light gray), metallic gray in accordance with FED-STD 595.

PART 3 EXECUTION

3.1 INSTALLATION

Switches shall be installed in accordance with the detailed instructions of the manufacturer.

3.2 GROUNDING

Switch tanks, mounting frames, and operating mechanisms shall be solidly bonded to the station ground counterpoise.

3.3 FIELD TESTING

Field Test Reports shall be submitted for Insulation Resistance Tests and High Voltage 60 Hertz Withstand Test and comply with the following.

The load break switch assembly shall be disconnected from the power supply and feeder cables and the switch enclosure grounded before conducting insulation and high-voltage tests.

The load break switch assembly shall be given an insulation resistance test with a 2500 V insulation-resistance test set.

All tests shall be applied for not less than 5 minutes and until three equal consecutive readings one minute apart, are obtained. Readings shall be recorded every 30 seconds during the first 2 minutes and every minute thereafter. The minimum acceptable resistance readings are 100 megohms.

Upon satisfactory completion of the insulation resistance test, the load break switch shall be subjected to a high-voltage, 60-hertz withstand test. The test voltage shall be equal to 75 percent of the factory test values and shall be applied for one minute.

Upon satisfactory completion of the high-voltage, 60-hertz withstand test, the switch assembly shall be given a second insulation-resistance test, as before. The results of the second insulation-resistance test shall be within 5% of the first test values and shall indicate no evidence of permanent injury by the high-potential test.

3.4 OPERATION AND MAINTENANCE MANUALS

The O&M manual shall be a complete manual containing all the required information as identified below and shall be grouped by equipment consisting of manufacturer's standard brochures, schematics, printed instructions, and procedures.

Maintenance Instructions - Provide procedures for preventive maintenance of all equipment. The procedure shall identify the time-based frequency to inspect; condition monitor; perform predictive testing; adjust, lubricate, clean, and change filters to ensure an effective and reliable maintenance program of each component, device, system, and of the integrated system itself.

Operating Instructions - The instructions shall include startup, shutdown, safety, normal and emergency operation procedures; testing and startup instructions; and pre-startup maintenance and operating checkouts. The procedures shall include electrical and mechanical schematics, control diagrams, ladder logic diagrams for any PLC's, and control sequence of operations that describe the entire range of equipment operations with all the parameters for alarm, shutdown, and control set points. The operating instructions shall address the physical and functional relationship of equipment within a system and include integrated operational instructions and electrical interconnect drawings. These drawing shall be in one-line drawing form showing the layout of all controls and the interconnection between systems.

Parts List - A list of parts, tools, and components for the system by manufacturer's name, part number, nomenclature, and quantity.

Preventive Maintenance and Inspection - Procedures and instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication, and cleaning necessary to minimize corrective maintenance and repair.

Repair Requirements - Provide procedures to checkout, troubleshoot, repair, and replace components of the equipment or systems. The procedures shall include manufacturer's integrated electrical schematics and diagrams, and diagnostic techniques necessary to totally troubleshoot the mechanical, electrical, electronic, and pneumatic components or systems.

Safety Considerations - Information relating to load limits, speeds of operation, environmental criteria, temperature and pressure limitations, and personnel hazards and equipment safety precautions.

Spare Parts Data - Data shall include a complete list of recommended spares by part number and nomenclature and spare stocking levels, with current unit prices and source of supply to ensure efficient operation for a period of 120 days at the particular installation.

Special Tools - A list of special tools and test equipment required for maintenance, repair, and testing of the equipment.

-- End of Section --